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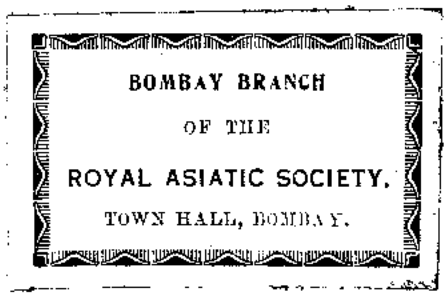

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THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. XXVIII.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND THE LATE

CAPTAIN FRANK TOURLE THOMSON, R.N.

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PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

Sir C. WYVILLE THOMSON, Knt., F.R.S., &c.

REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH

DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

AND NOW OF

JOHN MURRAY, LL.D., Ph.D., &c.

ONE OF THE NATURALISTS OF THE EXPEDITION

ZOOLOGY—VOL. XXVIII.

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CONTENTS.

REPORT on the SIPHONOPHORÆ collected by H.M.S. CHALLENGER during the years 1873–1876.

By ERNST HAECKEL, M.D., Ph.D., Hon. F.R.S.E., &c., Professor of Zoology in the University of Jena.

(*The Manuscript was received in Instalments between* 8*th February and* 5*th July* 1888.)

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EDITORIAL NOTE.

During the voyage of the Challenger, species of Siphonophoræ were continually under observation in the living condition, both on the surface of the ocean and in tanks on board the vessel; none of the naturalists, however, made any special study of this interesting and complicated group of animals; the specimens collected were merely preserved with as much care and skill as was possible in the circumstances.

Probably no class of marine organisms presents, in general, greater difficulties in the way of examination than the Siphonophoræ, and these difficulties are increased many fold when the naturalist has to deal with collections preserved in alcohol and other media, which contract and distort the specimens. Indeed it was essential that any naturalist who would undertake a successful examination and interpretation of these varied forms should himself have investigated these organisms during many years in the living state.

Professor Haeckel, through his long-continued and elaborate investigations of living Siphonophoræ and Medusæ in the Mediterranean, Indian, and Atlantic Oceans, was in a very special manner fitted to undertake such a task, and it must be regarded as fortunate that he should have been willing to undertake the work on condition that some of his own unpublished observations should be incorporated.

This important and masterly Report has thus become a Monograph of the whole class, more complete than any hitherto published; the classifi-

cation has been reformed and placed on a new basis. The new order, Auronectæ, discovered by the Challenger in the depths of the ocean, is particularly interesting to naturalists.

The Introduction, giving a general account of the morphology of the order, was translated from the German Manuscript by Mr. J. Arthur Thomson, M.A., F.R.S.E. All the remaining part of the Report was written by Professor Haeckel in the English language.

This REPORT on the SIPHONOPHORÆ forms Part LXXVII. of the Zoological Series of Reports, and consists of 383 pages and 50 chromo-lithographic plates.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, *October* 13, 1888.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the SIPHONOPHORÆ collected by H.M.S. Challenger during the Years 1873–76. By ERNST HAECKEL, M.D., Ph.D., Hon. F.R.S.E., Professor of Zoology in the University of Jena.

PREFACE.

THE Siphonophoræ collected by the Challenger during her cruise round the world were handed to me for investigation in 1879. The examination of this material, among which were to be found many new and remarkable types (especially abyssal forms), led me to recommence my study of the organisation and development of the whole class, which had been interrupted for more than ten years. During a residence of three months at Puerto del Arrecife, the harbour of Lanzerote in the Canary Islands, December 1866, January and February 1867, I had the opportunity of becoming acquainted with nearly all the typical forms of this most attractive group of animals. The facts which I then discovered regarding the curious, but till then little known, ontogenesis of these Acalephs, were embodied in a prize essay published by the Gesellschaft für Kunst und Wissenschaft in Utrecht.[1] I then intended to follow up this embryological memoir with a more extensive comparative anatomical one, or if possible a Monograph, in which also the systematic arrangement of the Siphonophoræ should be subjected to a thorough revision, and the very intricate literature of this class critically elucidated. The completion of this scheme was, however, deferred owing to various external hindrances, and the rich material collected at Lanzerote remained for the most part unpublished.

[1] Zur Entwickelungsgeschichte der Siphonophoren, Utrecht, 1869, 14 plates.

In the meantime I found many opportunities of continuing my researches into the Siphonophoræ during the numerous journeys which I undertook for the purpose of completing my System der Medusen, and to which I made some reference in 1879 in the preface to that monograph. I also collected much valuable material in the different museums which I visited for the same purpose. A further supply of specimens, and among them many new and instructive forms, were received from various travellers, and notably from Captain Heinrich Rabbe of Bremen. Lastly my journey to India furnished me with a long wished-for opportunity of becoming acquainted with the rich though little known Siphonophoral fauna of the Indian Ocean; on the journey out to Ceylon (*via* Bombay), on my return home (*via* Socotra), and especially in the expeditions which I made from Belligemma and Matura, I observed a number of new genera, some of which were exceedingly interesting (November 1881 to March 1882). At the same time I was able to extend my earlier observations upon the development and metamorphosis of the Siphonophoræ.

Valuable systematic contributions were also derived from the study of the excellent original drawings and the manuscripts of Mertens, of which Brandt gave a short account in 1835. I am highly indebted to Professor Alexander Strauch in St. Petersburg for the opportunity of examining these drawings which Mertens took in 1827 from living Siphonophoræ in the North Pacific, and which, unfortunately, have never been published; they are among the best and most life-like representations of the class that have ever been produced.

I take this opportunity of expressing my best thanks to those gentlemen who have assisted me in this investigation, especially to those travellers and directors of museums who have furnished me with material. By their aid I have been enabled to extend our knowledge of this group, and by the discovery of new morphological types to bring it to a certain degree of completeness. I am especially indebted to my honoured friend, Dr. John Murray, who with the greatest liberality offered to me all the Siphonophoræ collected by himself, and gave me permission to incorporate my own rich materials in this Monograph. My sincerest thanks are due also to the excellent artist, Mr. Adolph Giltsch, who, aided by his morphological interest and unwearying care, executed the chromo-lithographic Plates of this Report with such perfection, that they will give a complete idea of this most wonderful class of animals.

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GENERAL INTRODUCTION.

THEORIES AS TO THE ORGANISATION OF SIPHONOPHORÆ.

The morphological and physiological peculiarities which distinguish the Siphonophoræ from other Acalephæ have led, as every zoologist is aware, to very diverse theories as to the real nature and import of their organisation. Two essentially different interpretations still stand in marked antithesis to one another, and these may for the sake of brevity be described as the *Poly-organ* and *Poly-person* theories. Of these the poly-organ theory is the older (Eschscholtz 1829, Huxley 1859, P. E. Müller 1871, Metschnikoff 1874). According to this view the adult organism of all Siphonophoræ is a simple "Medusa-like animal," which is distinguished from the typical Medusæ only in the multiplication and differentiation of its polymorphic organs. More accurately defined, the organism remains an individual Hydromedusoid person (a morphon of the third grade, or a "morphological individual of the third order of individuality").

In contrast to this older interpretation is the poly-person theory (Vogt 1848, Leuckart 1851, Kölliker 1853, Gegenbaur 1854, Claus 1863, Chun 1882). According to this view the adult Siphonophoral organism is a colony of animals, composed of many polyp-like individuals, which, according to the laws of the division of labour, have to undergo various modifications, both in the way of specialisation and retrogression. More accurately expressed, it is a "swimming Hydropolyp stock or corm," composed of many polymorphic persons, partly polypoid, partly medusoid (a morphon of the fourth grade, or a "morphological individual of the fourth order of individuality").

Since in the course of the last two decennia the *ontogeny* of Siphonophoræ has become better known, and since the latter has in the light of the theory of descent been interpreted in causal relation to *phylogeny*, the main antithesis between the two theories has become more marked. According to the poly-organ theory the ontogenetic primitive form of the Siphonophoræ is a simple Hydromedusoid person, and with this is involved the phylogenetic corollary that the whole class originally arose from Medusæ. According to the poly-person theory, on the other hand, the ontogenetic primitive form is a swimming Hydropolyp stock, and with this is associated the phylogenetic corollary that the whole class sprang from Polyps.

According to the present opinion of most zoologists, which we also share, the low sessile Hydropolyp form is the more primitive; the higher Hydromedusa form has been secondarily developed at a much later stage, and that by adaptation to a free-swimming mode of life. In this way has the characteristic swimming organ of the Medusæ arisen, namely, the umbrella, with its radially constructed gelatinous disc, which was entirely absent in the primitive ancestral forms—the Polyps. The most important structure of the latter, however, the gastral tube (inherited from the Gastræa), has been transmitted to the Medusæ, and has become the "manubrium," in the wall of which the generative products are developed.

If we apply this fundamental and firmly based conclusion to the two theories of Siphonophore organisation, the following is evidently the antithesis in regard to the question of origin. According to the poly-organ theory the primitive form of Siphonophoræ was a simple Medusa and already possessed an *umbrella*; from this established swimming organ the various locomotor organs of the Siphonophoræ (swimming-bells and air-chambers) are derived by multiplication and modification. According to the poly-person theory, on the other hand, the primitive form of the Siphonophoræ was a Hydropolyp colony, and possessed *no umbrella*; the locomotor organs which are present are therefore new structures, not to be derived from any pre-existing swimming organ of the primitive form. And this leads to a weighty contrast in regard to the Medusiform larvæ, which arise directly from the gastrulæ of Siphonophoræ. According to the poly-organ theory, such a larva possesses essentially the morphological value of a simple Medusoid person, and as the hereditary repetition of the original primitive form has the greatest palingenetic importance. According to the poly-person theory, on the contrary, it possesses no such importance; it is merely of subordinate kenogenetic value, and is to be regarded as a peculiarly modified Hydroid polyp.

Both these opposing theories have been for forty years supported with much acuteness by distinguished zoologists, but yet without decisive conclusion; both are in fact partially justified; both contain a mixture of truth and error. According to my own opinion, which is based on an extensive comparative investigation of the entire class, and on numerous new facts discovered in the process, the truth lies midway between the two interpretations. The poly-organ theory is right in starting in its whole interpretation and rationale of the Siphonophoræ from a Hydromedusoid type, in regarding the primary medusiform larva as *palingenetic*, and further in supposing an extensive *multiplication* and *dislocation* of the several Medusa organs. It is wrong, however, in attributing to the fully developed Siphonophoral corm the value only of a person, and in regarding the persons which compose the stock purely as organs in the morphological sense. The poly-person theory, on the other hand, is right in explaining the fully developed Siphonophore as a *corm* (colony or stock), composed of many *polymorphic persons*. It goes, however, much too far, and is in error when it seeks to

attribute to the several (morphological) organs of these persons the same individual value (*e.g.*, to the single protective bracts and capturing filaments); is furthermore wrong in denying an extensive secondary multiplication and dislocation of these organs; and finally is especially at fault in regarding the primary medusoid larva as a merely *kenogenetic* embryonic form, and, by ignoring the palingenetic value of the latter, in interpreting the Siphonophoræ as "swimming Hydropolyp colonies" comparable to Hydractinia.

MEDUSOME THEORY.

The new theory of the organisation of Siphonophoræ to which I have been led by my investigations on their comparative anatomy and ontogeny may be briefly designated as the *Medusome Theory.* It seeks to incorporate the elements of truth in the two views above described, but to avoid their errors. The principal positions of this restatement may be briefly resumed:—

1. The primary larva, which arises directly from the gastrula of the Siphonophoræ, is always a simple Medusa; it may be more or less kenogenetically modified, but always retains a predominant palingenetic import, and is explained by the immediate derivation of the Siphonophoræ from Hydromedusæ.

2. The primary medusiform larva of the Siphonophoræ appears in two essentially distinct forms, as a *Disconula* and a *Siphonula;* and since this distinction is associated with essential differences in the resulting Siphonophoral colonies, the class may be legitimately divided into two legions or subclasses,—Disconanthæ and Siphonanthæ.

3. The first legion, or Disconanthæ, including the single order Chondrophoridæ or Porpitariæ, develops from a regular and octoradial Medusoid larva (*Disconula*), retains the original corona of marginal tentacles throughout life, and produces the persons of the colony by annular budding from the subumbrella.

4. The second legion, or Siphonanthæ, on the other hand, includes all the other Siphonophoræ (Calycophoridæ, Physophoridæ, Pneumatophoridæ, Aurophoridæ); its primary larva is a bilateral Medusa (*Siphonula*), which is distinguished by a ventral umbrellar cleft and by the possession of a single tentacle; it forms the persons of the colony by one-sided linear budding from the stomach-wall or manubrium.

5. The primary larva of the Disconanthæ (*Disconula*) is to be regarded as the ontogenetic recapitulation of a common primitive octoradial ancestor (*Archimeda*); and its phylogenetic origin is probably to be sought among the Trachomedusæ (Trachynemidæ; Pectyllidæ).

6. The primary larva of the Siphonanthæ (*Siphonula*) is to be regarded as the ontogenetic recapitulation of a common primitive bilateral ancestor (*Protomeda*), and its origin is probably to be sought among the Anthomedusæ (Codonidæ, Euphysidæ).

7. All the parts which arise by budding from the primary larva of the Siphonophoræ are either medusiform persons or special organs of the same.

8. All organs which belong originally to one medusoid person are included in the definition of a *Medusome*, whether they bud out from a common basis on the stem, or arise in different positions, in consequence of kenogenetic migration or dislocation; the multiplication of individual equivalent portions (*e.g.*, nectophores, bracts, palpons) which often occurs secondarily is simply to be regarded as a multiplication of organs, not of persons or medusomes.

9. The medusomes appear on the Siphonophoral colony in two distinct main forms, which cannot however be sharply distinguished—in the *palingenetic medusomes* the principal organs have remained more or less in their original connection (*e.g.*, in the gonophores of *Eudoxia*); in the *kenogenetic medusomes*, on the other hand, the principal organs are more or less dislocated, *e.g.*, in the sterile medusome of *Eudoxia*, which consists of a protective piece (umbrella) and a gastral tube (siphon) with a tentacle.

10. The lateral budding of the secondary medusomes (appendages) on the Siphonophoral stem occurs sometimes singly and sometimes in groups. Those groups which consist of several medusomes we call "cormidia."

11. The cormidia are originally simple segmental repetitions of a medusome-group in metameric succession separated by free internodes (*cormidia ordinata*), *e.g.*, the *Eudoxiæ* of the Calycophoridæ, the *Prodoxiæ* of the Physophoridæ (*Apolemia*, &c.).

12. By the breaking up of such original cormidia, those centralised corms arise in which the persons bud in a scattered fashion over the stem, their several organs thus becoming separate from one another (*cormidia dissoluta*), *e.g.*, *Agalmopsis*, *Rhizophysa*.

13. The degeneration of the single *medusomes* and of the disassociated *organs* is of the greatest importance in the development of the Siphonophoral colonies, and that the more, the more markedly the corm is centralised and the more intimate the mutual relations between the polymorphic medusomes.

DISCONULA LARVA OF THE DISCONANTHÆ.

Among the different medusiform larvæ of Disconanthæ (Chondrophoridæ or Porpitariæ) which I was able to observe, the youngest larvæ of Porpitidæ (from 0·1 to 0·4 mm. in diameter) are of special importance. They possess a circular, flatly arched disc, the margin of which bears a circle of eight simple tentacles. From the middle point of the subumbrella hangs a large central gastral tube, and from the base of this siphon arise at equal distances eight radial canals, which run in the concave subumbrella to the margin of the disc, and are there united in a circular canal. Above this there lies in the middle of the gelatinous disc a pneumatophore, composed of a central lens-shaped air-flask and a circle of eight radial air-chambers surrounding the same. Both

the former and each of the latter possess on the middle of their upper surface an external aperture (the stigma of the exumbrella). Only in the possession of this hydrostatic apparatus is this Disconula distinguished from an ordinary eight-rayed entirely regular Hydromedusa. Certain Trachomedusæ (Trachynemidæ, Pectyllidæ) present a most striking resemblance. Even in another further advanced larval stage, which we may call a *Porpula*, the regular structure of a simple Craspedote person is still retained. The *Porpula* is distinguished from the *Disconula* in this, that the number of marginal tentacles has increased from eight to sixteen, and several concentric annular air-chambers are apposed to the primary circle of eight. In a still later stage the number of concentric air-chambers is greatly increased, and the tentacles form several rows at the margin of the umbrella. Then between the margin of the umbrella and the central siphon, eight or sixteen conical buds grow out from the subumbrella—the subsequent bearers of the gonophores. They remain closed in the monogastric Discalidæ, but acquire a mouth opening in the polygastric Porpitidæ and Velellidæ. The youngest larvæ of the Velellidæ are hardly to be distinguished from those of the Porpitidæ; the difference between them only becomes distinct when in the former the vertical skin-fold of the exumbrella begins to be developed (*Rataria*), in the base of which is formed the diagonal crest of the pneumatophore which determines the *amphithect* ground-form of the Velellidæ. Their youngest larvæ, however, are as octoradial as those of the *regular* Porpitidæ. At an early stage they are distinguished by this, that in the Porpitidæ each of the eight radial air-chambers forms a stigma, in the Velellidæ only two lying obliquely opposed. The resemblance between these larvæ and the Pectyllidæ suggests that the Disconanths have been originally developed from this group of Craspedotæ. If the eight sac-shaped gonads, hanging down from the subumbrella of the Pectyllidæ, were not themselves reproductive organs, but medusoid gonophores, and if above these in the gelatinous substance of the disc, a glandular depression or exumbrellar invagination led to the constriction of an air-sac, then from a Pectyllid or Trachynemid there would be derived a very simple Discalid.

SIPHONULA LARVA OF THE SIPHONANTHÆ.

Entirely different from the first stage in the development of the Disconanthæ, is that of the second legion—the Siphonanthæ (Calycophoridæ, Physophoridæ, Pneumatophoridæ, Aurophoridæ). Different as are the Siphonophoræ of this manifold legion in their fully developed form, their primary larval forms are very similar, at least so far as their ontogenetic history is yet known. The Siphonula—or the primary medusiform larva—is in this legion from the first not octoradial and regular, but bilaterally symmetrical. The original circle of tentacles on the umbrellar margin has disappeared; in all cases only a single capturing filament (Fangfaden) persists, the *primary unilateral*

larval tentacle, which in consequence of the ventral umbrellar cleft has been shifted centripetally to the base of the gastral tube. The primary umbrella itself (*Protocodon*) has in consequence of this unilateral development become bilateral; it develops in the Calyconectæ (or. Calycophoridæ) into the primary swimming-bell, in the other three orders (Physonectæ, Cystonectæ, and Auronectæ) into the pneumatophore. The "swimming-bladder" arises here again as a gland-like invagination of the ectoderm, not however *centrally* in the apex of the exumbrella (as in the Porpitariæ), but in an *excentric* position. The primary siphon (*Protosiphon*) persists in the monogastric Siphonanths as a single stomachic tube; while in the polygastric forms it develops into the stem from which all the other persons of the colony proceed by lateral budding. The whole structure of the Siphonanthæ, as well as that of their Siphonula larvæ, suggests the closest relationship with the Anthomedusæ, and especially with the family of Codonidæ. Only in these Anthomedusæ do the reproductive elements develop in the entire gastral wall (as in the manubrium of the gonophores in all the Siphonanths), without hint of radial divisions. Among the Codonidæ, however, the subfamily Euphysidæ (particularly *Hybocodon* and *Amphicodon*) is of especial importance. Here only do three of the four primary tentacles of the umbrellar margin disappear, and one alone remains to attain a proportionately greater development. In this way the bilateral modification of the umbrella is determined. This origin of the Siphonanths is also corroborated by the marked tendency of many Anthomedusæ to form Medusæ by direct budding from the gastral tube (*Codonium gemmiferum, Sarsia siphonophora*, &c.). Since these Euphysidæ develop from Tubularian polyps of the genus *Corymorpha*, the latter are probably to be regarded as the older ancestral forms of the Siphonanthæ.

CORM AND CORMIDIA.

All Siphonophoræ are pre-eminently characterised by the development of a stock (corm or colony), that is to say, of an individual organism which is composed of several polymorphic persons (*zooids* or "individuals proper"). The laws and modifications of this compositeness or colony-formation have been as yet but slightly investigated, though they are undoubtedly very interesting and important. I distinguish in the first place simple and multiple colonies. The simple colony (*Cormus simplex*) consists of a single centralised group of persons, as in all Disconanthæ and in the *monogastric* Siphonanthæ. The compound or multiple stock, on the other hand (*Cormus compositus*), is formed from the union of several individualised groups of persons, or "groups of individuals scattered upon the stem,"—the *Cormidia*. Such colonies are represented by the *polygastric* Siphonanths. Each cormidium usually represents, in its general composition of several polymorphic persons, a simple stock, and is in most cases monogastric. There are, however, polygastric cormidia, *e.g.*, *Apolemia*, *Salacia*, *Physalia*. In all

polygastric Siphonanthæ the cormidia are lateral, originally metameric branches of a segmented trunk or jointed stem. This appears, however, in very varied form, as the cormidia occur in distinct order or irregularly scattered and dissolved.

ORDINATE CORMIDIA.

In most polygastric Siphonanths (and therefore in the great majority of now existing genera of Siphonophoræ) the cormidia are ordinate, that is, regularly arranged as the metameres of the jointed stem or corm axis; the internodes, or regular intervals of the stem between each two cormidia, are often quite free, especially in much elongated corms, as for instance in almost all polygastric Calyconectæ, in a number of the Physonectæ (Apolemidæ, many Agalmidæ) and of the Cystonectæ (Salacidæ, many Rhizophysidæ). Not unfrequently in these stocks the elongated stem is so strikingly jointed by the annular strictures separating the internodes at equal intervals, that the uniform and all-pervading metameric structure of the Articulata is quite equalled. This comparison is the more permissible, since the apical portion of the stem (representing the head) is distinguished by the higher morphological differentiation of its group of persons. The poly-organ theory might conceive these regularly jointed forms as *Siphonophoræ articulatæ* in contrast to the others or *Siphonophoræ inarticulatæ*. But even when the stem is much shortened and the cormidia so closely compressed that the internodes are hardly distinguishable, the cormidia are often arranged with great regularity in a compressed spiral row, as in the Discolabidæ and Rhodalidæ. In others, and often in nearly related forms, the regular arrangement disappears, and gradually passes into the scattered disposition of *Cormidia dissoluta*.

DISSOLVED CORMIDIA.

While in the majority of polygastric Siphonanths the corms are distinctly articulate, and the cormidia are arranged in regular succession, this original arrangement is more or less lost in one portion of this group, and in some entirely. The dissolution usually begins in this way, that the siphons and gonophores belonging to one cormidium separate; the latter bud off directly from the stem, often regularly alternating with the first, as in *Polyphyes* among the Calyconectæ, in *Linophysa*, *Nectophysa*, *Rhizophysa*, among the Cystonectæ, and in many Agalmidæ among the Physonectæ. In consequence of further dissolution of the stem arrangement, the palpons and the bracts also lose connection with the cormidia, and bud out directly from the stem, as in several Agalmidæ and Forskalidæ. Finally the ordinate arrangement is quite lost, and the entire stem exhibits hundreds or thousands of different appendages (siphons, palpons, gonophores, bracts, &c.) in irregular grouping, so that it is impossible to distinguish

the various connected components of the broken up cormidia (*Physalia, Agalmopsis*, and other Agalmidæ). This appearance is of the greatest interest, because, within one and the same family (*e.g.*, Agalmidæ, Rhizophysidæ), most nearly related genera exist, of which one possesses perfectly ordinate cormidia, another completely scattered, and a third an exact transition between these two. In this fact lies the direct morphological evidence of the multiplication and dislocation of the portions of the Siphonophoral stock.

DISLOCATION AND MULTIPLICATION OF ORGANS.

If our medusome theory is correct, the title of real *persons* (or "individuals proper") is only to be applied to those portions of the Siphonophoral stock which have originally the morphological value of a medusome-person, and not to those portions which were originally only organs of such a person. If this be so, it is necessary to assume in many cases a far-reaching dislocation and multiplication of the parts which were originally organs of a medusome. This assumption is directly supported by the fact that the replacement of primary organs by equivalent secondary structures does to a very large extent take place. As such vicarious organs (*reserve* or *replacement* organs, "Ersatz-organe"), I interpret, for instance, the numerous swimming-bells and covering bracts of many Physonectæ, the successive heteromorphic swimming-bells of the Calyconectæ, the groups of palpons in many Physonectæ. On the other hand, in such an instance as the clustered groups of reproductive members, each separate "gonophore" is to be interpreted as a medusoid person which has lost mouth-opening and tentacles. The morphology and "sociology" of the Siphonophoræ must take much more account than heretofore of these important tectological distinctions, and the rank of individuality must be more strictly defined.

MONOGASTRIC AND POLYGASTRIC CORMIDIA.

The ordinate cormidia contain usually only a single siphon, more rarely two or more. The most important forms of *monogastric cormidia* (with a single siphon) are the following:—

1. The *Eudoxome* of the Calyconectæ (often becoming free as a "*Eudoxia*"), in which each cormidium consists of two persons, one sterile (siphon with tentacle and covering bract) and one fertile—the gonophore (often with accessory gonophores).

2. The *Ersæome* of the Calyconectæ (often becoming free as an "*Ersæa*"), in which each cormidium consists of three persons, having a medusoid "special swimming-bell" added to the two persons above mentioned in the eudoxome.

3. The *Rhodalome* of some Rhodalidæ, of *Hippopodius*, *Vogtia*, *Aurophysa*, *Canno-*

physa, Arethusa, &c., in which each cormidium consists of a siphon with a tentacle and of one or more gonophores.

4. The *Athorome* of *Physophora* and of the Anthophysidæ, in which each cormidium consists of a siphon with a tentacle, one or more palpons, and one or more gonophores.

5. The *Crystallome* of *Crystallodes, Anthemodes* and other ordinate Physonectæ, in which each cormidium consists of a siphon with a tentacle, one or more palpons, one or more gonophores, and a group of bracts.

Much rarer and much less manifold are the ordinate *polygastric cormidia*, in which each group of persons contains several siphons (each with a tentacle); such occur in *Apolemia* among the Physonectæ, and in *Salacia* among the Cystonectæ. The line of the stem, in which the cormidia originally bud forth in uniform succession, is the ventral median line of the protosiphon; usually it is rolled up in a wide or narrow spiral, rarely it remains straight (*Crystallodes, Stephanomia*).

STEM OR TRUNK.

(*Cœnosome, Cœnosarc, Axial Body.*)

The stem of the Siphonophoræ, or the central axial body, on which all the various persons and organs of the corm are attached, is generally compared to the stem of a Hydropolyp stock. This comparison is in our opinion in the accurate sense illegitimate; for in the latter the primary larval body from which the corm develops is a Polyp-person, while in the former it is a Medusa-person. The comparison holds so far, however, inasmuch as the trunk is branched in both cases. It is not logical to describe the stem of the Siphonophoræ as "unbranched" as is generally done. In reality it is always branched, for all the appendages—whether they be interpretable as *persons* or as *organs*—arise as lateral branches of the axial body. Only the forking or *dichotomous ramification* is here absent. Further, the conventional description which is generally given of the stem or axial body of the Siphonophoræ is strictly applicable only to one legion of the class—to the Siphonanthæ. For it is here only that the stem (whether it be long or short) is formed from the *primary siphon*, and has all its appendages (or branches) budded off in a row from its ventral median line. That they are subsequently often radially disposed depends wholly upon a secondary spiral twisting of the stem, and displacement of its appendages. It is quite different in the second legion, the Disconanthæ. Here the proper stem, *i.e.*, the common central portion of the corm, is formed from the *primary umbrella*, and all its appendages (or branches) bud out from its lower or subumbrellar surface, not in one row, but in concentric circles or rings, which are originally octoradial. On the other hand the primary siphon in this legion has only the value of a central nutritive organ.

NECTOSOME AND SIPHOSOME.

In all Siphonophoræ, without exception, both in the *monogastric* and *polygastric* forms, the developed corm may be distinguished, both from a morphological and from a physiological point of view, into two main portions, the nectosome and siphosome. The *nectosome* or the swimming body forms in the Siphonophoræ which swim quietly on the surface of the sea, the upper, anterior or proximal portion of the stock; the *siphosome* or nutritive body the lower, posterior or distal portion. Physiologically the former is the organ of locomotion (and often also of respiration), the latter, on the other hand, the organ of nutrition and reproduction. If one compares the Siphonophoral stock with the simple medusoid person, then the *nectosome* in general represents the *umbrella*, and the *siphosome* of the corm the *manubrium* of the Medusa. In the polygastric Siphonanths the two portions pass through an independent course of development, separated from one another, with distinct points of growth. In those Siphonanths where the stem is spirally coiled, the spiral twisting is usually opposite in the two portions; the nectosome has usually a left-handed ("Lambda"), the siphosome a right-handed ("Delta"), spiral.

NECTOSOMES OF THE FIVE ORDERS.

The swimming apparatus of the Siphonophoræ is formed of two essentially different organs, the swimming-bell (*nectophore*) and the swimming-bladder (*pneumatophore*). The nectophore is the umbrella of a Hydromedusa, in which both the annular muscular layer of the velum and of the subumbrella, and the primary canal-system (four radial canals united by a marginal circular canal) are perfectly developed. The pneumatophore, on the other hand, is an invaginated and much modified umbrella, in the surface of which (by apical or lateral invagination of a gas-gland) a chitinous gas-filled "air-flask" or pneumatocyst is formed. The definition of the five Siphonophoral orders is in the first place determined by the different formation of the swimming apparatus.

I. The Calyconectæ or Calycophoridæ possess only one, two, or more swimming-bells, but no pneumatophore.

II. The Cystonectæ or Pneumatophoridæ bear only a simple large pneumatophore, but no swimming-bells.

III. The Disconectæ or Chondrophoridæ possess an octoradial pneumatophore, usually composed of concentric annular chambers, but no swimming-bells.

IV. The Physonectæ or Physophoridæ bear on the apex of the stem a simple pneumatophore, and under that a biserial or multiserial column of swimming-bells; sometimes instead of these a corona of numerous bracts.

V. The Auronectæ or Aurophoridæ (a new and hitherto quite unknown group of very remarkable deep-sea forms) possess on the apex of the stem a colossal pneumato-

phore, and underneath that a (simple or multiple) horizontal corona of swimming-bells, and in the middle of the latter (in the dorsal median line of the nectosome, opposite the ventral row of buds) a large aurophore, a new, hitherto unknown organ, which is to be regarded as a swimming-bell modified into a large gas-gland.

NECTOPHORES OR SWIMMING-BELLS.

(*Nectocalyces, Nectozooids, Schwimmglocken, Schwimmhöhlenstücke.*)

The swimming-bells generally exhibit so clearly the structure of the *umbrella* of a simple hydromedusa person, that there can be no doubt as to their morphological import as the locomotive organ of such a person—in the sense of the poly-organ theory. The cavity of the gelatinous disc is clad throughout by the circular muscle layer of the subumbrella, and its distal margin protrudes in the form of a true velum, at the base of which runs the circular canal which unites the four-radials. The poly-person theory interprets these facts, however, in this way, that each swimming-bell is to be regarded as a medusoid *person* or "locomotive zooid," in which the locomotor umbrella is well developed, but the nutritive manubrium degenerated. To this the medusome theory has to reply that such a phylogenetic interpretation is not corroborated by the known ontogenetic facts. The protocodon, or the "*primary swimming-bell*" of the Siphonula is only an *organ* of this medusoid person. It does not remain as such in most (if not all) of the Calyconectæ, but becomes thrown off, and replaced by metacodons or *heteromorphic* "*secondary swimming-bells.*" In the monogastric Calyconectæ the protocodon is modified into the covering bract of the Eudoxia, while in the Physonectæ, Cystonectæ, and Auronectæ it becomes the pneumatophore. The numerous metacodons, which in the Physonectæ and Auronectæ, as well as in the Polyphyidæ, form the two-tiered, many-tiered, or radially disposed swimming column, are either displaced umbrellas of medusomes, which are repeated metamerically in the several cormidia, or are simply *vicariæ* or "reserve bells" ("Ersatzglocken") which arise by the multiplication of such umbrellas, and are often present in great numbers.

PNEUMATOPHORE OR SWIMMING-BLADDER.

(*Air-Chamber, Luftkammer, Schwimmblase.*)

The hydrostatic organ of the Siphonophoræ, which is known as *pneumatophore*, is only absent in one order, that of the Calyconectæ. In the other Siphonophoræ it is generally present and that in two different forms; the Physonectæ, Cystonectæ, and Auronectæ possess a simple swimming-bladder at the superior or apical pole of the stem;

the Disconectæ, on the other hand, have a complicated apparatus, composed of concentric annular chambers, which occupy the greater portion of the umbrella. In all cases the pneumatophore arises very early in the primary medusoid larva, and that by a gland-like invagination of the exoderm of the exumbrella. In the bilateral Siphonula of the Siphonanths this invagination has an excentric position (being often shifted down near to the umbrellar margin), but in the octoradial Disconula of the Disconanths it is central, in the very apical pole. The marked and apparently considerable differences of the developing pneumatophore, in relations both of time and space, between different (often nearly related) Physonectæ, I simply explain as secondary cenogenetic modifications. That portion of the medusoid larval body on which the first trace of it appears always belongs originally to the exumbrella.

In the Siphonanthæ the invaginated portion of the exumbrella, comparable to a simple, pouch-like, glandular sac, is known as the air-sac (*pneumatosaccus*); it secretes in its superior or apical half a chitinous membrane, the air-flask (*pneumatocystis*), while its inferior or distal portion (the "air-funnel") discharges the function of a gas-gland (*pneumadenia*). The glandular (usually yellowish or greenish) epithelium of this last portion secretes the air, which passes by the basal opening of the air-flask ("funnel aperture," "Trichterpforte," or *pneumatopyle*) into the latter. The Cystonectæ or Pneumatophoridæ possess at the apical pole of the pneumatocyst an external air-hole or stigma (the primary opening of invagination), by which the air may be discharged at will. In many Siphonanths the air-secreting glandular epithelium of the air-funnel (or infundibulum) grows through the aperture into the basal half of the pneumatocyst and clothes the latter as endocystal tapetum, or "secondary ectoderm" (Chun).

In most Siphonanthæ the air-sac becomes subsequently united with the peripheral (uninvaginated) portion of the primary umbrella—the *pneumatocodon*—by a number of vertical radial septa, usually eight, more rarely four or sixteen, and occasionally a variable number. The radial pockets between these septa open inferiorly into the central canal of the stem and represent the radial canals of a simple medusoid umbrella. On this is based the opinion that the entire air-chamber is to be regarded as an "invaginated swimming-bell" (Metschnikoff 1874). In contrast to this the air-chamber is at present regarded by most zoologists as an independent *medusoid person* (or "medusiform zooid"), and is supposed to originate as a "bud" from the primary larva (Leuckart 1875, Claus 1878, Chun 1887). The antithesis between these two opinions culminates in the interpretation of the air-sac, which according to the first theory is the *exumbrella* of a medusoid disc, according to the second the *subumbrella*. The latter opinion is according to my conviction entirely erroneous, the former is in a certain sense admissible. The comparative ontogeny of the Siphonophoræ appears to me to show conclusively that the air-sac is an apical gas-gland of the exoderm, which in the Disconula of the Disconanthæ sinks centrally into the gelatinous disc from the apex of the same inwards, and in the Siphonula

of the Siphonanthæ lies excentrically beside the apex. It arises in the former, indeed, at the place where some Medusæ (*e.g.*, *Aglaura*) form a suctorial organ of attachment. Only subsequently does this apical air-gland become greatly extended, to occupy the greater part of the original larval umbrella, so that one may in a certain sense speak of an "invagination." At any rate, the "air-sac" is originally a portion of the ectodermic epithelium of the *exumbrella*, not of the *subumbrella*. The whole pneumatophore is not a secondary medusoid person, but the modified disc of the primary medusoid larva.

The many-chambered pneumatophore of the Disconanthæ is comparable in its first beginning alone with the single-chambered pneumatophore of the Siphonanthæ; there again it is at first nothing more than an apical gas-gland, which occupies only a small area on the apex of the primary larval umbrella. This simple central chamber becomes rapidly surrounded, however, with a girdle of eight radial chambers, and around these again many concentric rings of chambers are apposed. Thus arises the characteristic octoradial, concentrically chambered air-disc of the Porpitidæ, of which the amphithect pneumatocyst of the Velellidæ represents only a secondary modification. Sometimes its margin is split into eight or sixteen radial lappets. On the upper surface the disc opens by numerous stigmata, of which the central one alone can be compared to the simple apical stigma of the Pneumatophoridæ. From the lower surface proceed numerous small air-tubules or tracheæ, which enter into the so-called "liver" or glandular central organ. I regard only the entodermic canal network of this voluminous "central organ" as "liver" (and perhaps "kidney"), and the compact exodermic parenchyma as a strongly developed gas-gland. The lower ends of the tracheæ are not closed, as is generally supposed, but open. They take off the secreted gas, and their terminal apertures correspond to the "funnel aperture of the air-flask" in the Siphonanthæ. On the other hand, the stigmata of the upper surface (or of the exumbrella) in the Disconanthæ do not serve for the reception of atmospheric air from outside (as is generally supposed), but solely for the exit of the secreted gases, and correspond to the simple apical pore of the Cystonectæ.

AUROPHORE OR AIR-BELL.

The new deep-sea families Stephalidæ and Rhodalidæ are distinguished from all the other Siphonophoræ by the possession of a peculiar organ, belonging to the nectosome, designated the *aurophore*. Since they are in other respects peculiarly organised, they may be regarded as representing a special order, Auronectæ. The aurophore is a voluminous gas-gland, which has developed out of a medusiform swimming-bell. It lies below the large pneumatophore, in the dorsal middle line of the stem, opposite the ventral row of buds. The disc-cavity of the swimming-bell has been modified into a

narrow muscular air-duct (*auroductus*), which opens internally at the base of the pneumatophore, and externally to the outside. The radial canals of the metamorphic nectophore are modified into a complex radial system of wide glandular chambers.

SIPHOSOME OR NUTRITIVE BODY.

The nutritive body exhibits in the different groups of the class Siphonophoræ much more manifold and important differences of form and structure than the swimming body. Undoubtedly the most important difference is this, that in the Monosiphoniæ (or the *monogastric* Siphonophoræ) the archisiphon or protosiphon (the primary gastral tube of the medusoid larva) remains alone as the organ for the reception and digestion of food, while in the Polysiphoniæ (or the *polygastric* Siphonophoræ), "secondary suctorial tubes" or metasiphons are developed by budding, each provided with a gastric cavity and a mouth opening. In the Polysiphoniæ the primary mouth opening of the medusoid larva only rarely persists, in all Disconanthæ, and in two families among the Siphonanthæ (Stephalidæ and Physalidæ). In most (perhaps all the rest) of the polygastric Siphonanthæ, the primary mouth opening of the protosiphon is probably closed, and the latter persists only as the stem of the stock (*truncus* or *cœnosome*).

The polymorphic appendages, which bud out as lateral branches from the stem of the siphosome, are partly medusoid (*bracts, gonophores*), partly polypoid (*siphons, palpons, cystons, gonostyles*). The poly-organ theory regards the former as multiplied umbrellas of one Medusa, or as secondary vicaria of such, the latter as repeated manubria or vicaria of the same. The poly-person theory, on the other hand, regards each single bract as a medusoid person, which has lost all its organs except the umbrella, and each single siphon and palpon as an independent Hydropolyp. Our medusome theory regards in the different cases these polymorphic appendages partly as dislocated organs of medusomes, partly as multiplied reserve organs or vicaria of the same.

SIPHONS OR SUCTORIAL TUBES.

(*Polypites, Gastral Tubes, Stomach Sacs, Nutritive Polyps, Eating Polyps, Hydranths, Gastrozooids.*)

The siphons, which have given the name Siphonophoræ to the entire class, are the most important and the most constant appendages of their organism. From a physiological point of view they are rightly regarded as organs for the reception of food and digestion; from a morphological point of view they are sometimes regarded as homologous with an entire Polyp, sometimes with the gastric tube or manubrium of a Medusa.

As in the latter, each siphon or "suctorial tube" possesses at the distal end of the sac-shaped body a mouth opening, at the proximal end a stem opening, through which the simple cavity communicates with the cavity of the umbrella or the stem. By one or two (often even three) annular strictures the simple cavity of the siphon is divided into two, three, or four chambers. When four portions can be distinctly distinguished, the first (proximal) is a thin stalk (*pedunculus siphonalis*), usually bearing the base of insertion of the tentacle; the second is a thick-walled crop ("Vormagen," *basigaster*) equipped with masses of urticating cells; the third is the stomach proper (*stomachus*), usually with "hepatic stripes," more rarely with glandular villi; the fourth is an extremely contractile proboscis. The stomach usually passes without sharp boundary into the proboscis, but is generally definitely marked off from the basigaster, often by means of a pyloric valve. The stalk of the crop region is often degenerate or not distinctly defined. The single tentacle springs from this portion in the majority of Siphonanthæ. According as the adult Siphonophoral corm has only one or several siphons, we distinguish Monosiphoniæ and Polysiphoniæ.

MONOSIPHONIÆ OR MONOGASTRIC SIPHONOPHORÆ.

Of great importance for the right understanding of the Siphonophoræ is the fact, that in all forms the primary medusiform larva (Disconula or Siphonula) bears only a single siphon, and that this remains in one portion of the class, namely in the Monogastricæ, while in the other division it is modified into the stem, and is physiologically replaced by numerous secondary siphons (lateral branches of the latter). Hitherto the monogastric Siphonophoræ have been represented solely by the *Eudoxiæ* among the Calycophoridæ; but among the new deep-sea Siphonophoræ of the Challenger Expedition which I have described in this Report, there are interesting monogastric forms from three other orders (Discalidæ, Athoridæ, Cystalidæ). Since in both legions of the class the Monosiphoniæ exhibit close resemblance to the known larval forms of the Polysiphoniæ, they may be regarded as "sexually mature larvæ." In more accordance, however, with the phylogeny is the reverse interpretation, that those larvæ of the Polysiphoniæ repeat, according to the fundamental biogenetic law, the structure of their Monosiphonial ancestors.

In regard to the position of the stomach on the subumbrella, the Monosiphoniæ exhibit in both legions very important differences, which are explained by their diphyletic origin. In the Discalidæ or monogastric Disconanths, the primary siphon occupies the central point of a regular octoradial umbrella; in the monogastric Siphonanths, on the other hand, it is more or less excentrically situated at the base of a bilateral umbrella.

POLYSIPHONIÆ OR POLYGASTRIC SIPHONOPHORÆ.

In the great majority of Siphonophoræ the adult form possesses several suctorial tubes or polypites as organs for the reception and digestion of food. These arise in the Disconanthæ by budding from the primary *subumbrella*, in the Siphonanthæ on the other hand by budding from the ventral middle line of the primary *siphon*, which is modified into the stem. In the former these "metasiphons" surround the primary archisiphon as a corona; while in the latter they are disposed upon the protosiphon either on the one side only or on all sides, in a spiral line. In the simplest and most primitive case, such as occurs in the polygastric Calyconectæ and in many Physonectæ, the metasiphons develop in regular metameric succession on the segmented stem, separated by wide internodes. Each individual siphon is (in the *Eudoxiæ* and the corresponding simplest *Prodoxiæ* of the Physonectæ) associated with a covering bract; both together form a medusome, the umbrella being represented by the bract, the manubrium by the siphon. In most of the Physonectæ numerous covering bracts soon develop, which are to be considered as mere multiplications of the primary bract, and therefore as entirely subordinate organs. But when from the base of such a medusome gonophores bud forth—appendages that is to say of the morphological value of a medusoid person—then such a "group of persons" acquires the value of a *cormidium*. In many Polysiphoniæ the metameric arrangement of the cormidia subsequently breaks up, and then the connection between the scattered siphons and the separated sexual medusomes is often no longer demonstrable.

PALPONS OR TASTERS.

(*Feelers, Tasters, Arms, Fluid Receptacles, Hydrocysts, Dactylozooids.*)

In the great majority of the Siphonophoræ, the siphosome bears, scattered between the siphons, or connected in groups with the latter, the tasters or feelers. These are always simple, thin-walled, very contractile sacs, in which the proximal portion communicates with the cavity of the stem, while the distal end is closed. Morphologically the tasters are to be regarded as mouthless manubria, or as the stomachic sacs of medusomes in which the umbrellas have become modified into covering bracts or are entirely degenerate. The palpons are distinguished from the cystons by the absence of a distal opening, from the siphons not in this alone, but also in the absence of the glandular villi and hepatic stripes in the stomach region. Their function appears to be mainly, if not exclusively, sensory. Their sensitive point probably acts generally as a taste organ, and sometimes also as an eye; in a (new) *Athorybia* I observed a lens in this ocellus (a sickle-shaped pigment spot on the upper surface of the sensory apex). In some Agalmidæ the distal

part appears to act as an otocyst, since it is constricted off by a strong sphincter from the wide palpon cavity, and forms a spherical terminal bladder in which a crystalline otolith is kept in rotatory movement by a ciliated epithelium. Palpons are found generally distributed in the Physonectæ and Physalidæ; they are absent in the Auronectæ, Calyconectæ, and Disconectæ. Not unfrequently palpons are confused with tentacles, as for instance repeatedly by Claus, even in *Physophora*.

CYSTONS OR ANAL VESICLES.

Under this title I distinguish from the other polypoid organs of the Siphonophoræ certain vesicular sacs, which have hitherto been generally confused with the palpons. They are indeed very like the latter, but are very essentially distinguished from them by a terminal aperture. By means of this aperture, which the animals can open or close at will, fluid and excretions are emptied from the canal-system, and water may also be taken in. It is therefore to be regarded as an anus. The distal portion of the cystons is frequently pigmented and furnished with special glandular cells, they also sometimes contain definite crystalline excreta. These anal vesicles obviously stand in closer morphological and physiological relations with the siphons than with the palpons; they are, however, distinguished from the former by the simple structure of the wall. I find these excretory structures widely distributed among the Physonectæ, but they appear to be altogether absent in the other orders.

TENTACLES OR CAPTURING FILAMENTS.

(Senkfäden, Stinging Filaments, Tentacular Filaments, Nematozooids.)

Tentacles are present in all Siphonophoræ, and are both as capturing organs and as offensive and defensive weapons quite indispensable. Recent reports of their absence in some species are certainly to be explained by the ease with which the delicate threads are during capture detached from their base. The poly-person theory regards the tentacles as independent polypoid persons. I agree, on the other hand, with the poly-organ theory, which explains them as organs of the siphons. In my opinion the tentacles of the two legions of the class are in their nature entirely different. In the Disconanths (or Porpitariæ) the primary circle of tentacles on the umbrellar margin of the medusoid larva (Disconula = *Archimeda*) persists; there are at least eight present; their number usually becomes much increased; they have no individual relations to the separate siphons which bud forth in large numbers from the subumbrella. It is

quite different in all the other Siphonophoræ—the Siphonanthæ. Even their primary medusoid larva (Siphonula = *Protomeda*) always possesses only a single tentacle, and this is excentrically attached to the base of the primary siphon. The phylogenetic cause of this peculiar position is to be sought in the bilateral modification, which the older four-rayed medusoid ancestors of this legion (Codonidæ) have undergone through the degeneration of three marginal tentacles (Euphysidæ). Only a single tentacle remained persistent, and was all the more strongly developed; it shifted in consequence of the ventral splitting of the umbrella to the inferior surface of the latter beside the base of the siphon. A similar *centripetal migration* of tentacles occurs also in Medusæ, sometimes on the superior, sometimes on the inferior surface of the umbrella. The fact that each individual siphon of the polygastric Siphonanths bears at its base only a single tentacle is simply to be regarded as the (hereditary) result of a metameric repetition of the primary condition.

Only in a few Siphonophoræ do the tentacles remain simple cylindrical filaments, as in the Velellidæ, in *Apolemia*, *Stephalia*, *Linophysa*, *Salacia*, and allied genera. In the great majority a row of lateral branches (side-filaments, accessory tentacles, secondary filaments, or Tentilla) is formed, as in the Cladonemidæ (*Pteronema*, *Gemmaria*). The terminal equipment of the latter by manifold cnidonodes or "stinging knobs" is often very characteristic of the several genera and species. The Porpitidæ are distinguished by the possession of three longitudinal rows of secondary branches. Some supporters of the poly-person theory regard each of these accessory organs as an autonomous person, and Claus even states that the mantle-like covering (involucrum) which in many Physonectæ surrounds each stinging knob, apparently corresponds morphologically to the disc of the Medusa (1878). In my opinion all these appendages, however complex their structure, are merely subordinate organs of the second order.

PALPACLES OR TASTING FILAMENTS.

Under this designation I include only the long, extremely contractile, hollow, simple filaments, which occur in the majority of Physonectæ at the base of the palpons. They have the same morphological and genetic relation to the latter as the *tentacles* to the *siphons*. While the tentacles are especially of importance as capturing organs and as weapons, the palpacles act as fine, far reaching, tasting organs auxiliary to the sensory function of the palpons. Each palpon bears always only a single palpacle, and this is always simple, never stalked. While the supporters of the poly-person theory regard each palpacle as an independent "individual," that is as a distinct person, I must on the other hand agree with the poly-organ theory, which explains them simply as subordinate organs of the palpons.

BRACTS OR COVERING PIECES.

(*Hydrophyllia, Protecta, Deckblätter, Covering Scales, Phyllozooids*).

The polymorphic organs which are usually spoken of as "covering pieces" (Deckstücke) are entirely absent in the three orders Disconectæ, Cystonectæ, and Auronectæ; in the former originally, in the two latter probably as the result of degeneration. In the two remaining orders the bracts are essentially distinguished in this, that in the Calyconectæ they appear singly on each Medusome, in the Physonectæ on the other hand there are several. Only the primary larva of the latter (Siphonula) frequently forms a single "primary covering piece" (*Protobractea*), which is then to be compared with the single bract of the former (*Eudoxia*), and to the umbrella of the primary ancestral form (*Protomeda*).

The physiological importance of the bracts consists exclusively in their protective function; they are shields or umbrellar organs, under the shelter of which the other persons of the colony are protected. As regards their morphological import, the poly-person theory regards them as degenerate medusoid persons, which have lost manubrium and tentacles, while the gelatinous disc has been the more developed; the poly-organ theory, on the other hand, regards them as multiplied umbrellas. According to our medusome theory, a distinction must be drawn between primary and secondary bracts. The protobracteæ or *primary covering pieces*, which occur singly, on the larvæ of Physonectæ and on the Eudoxiæ of Calyconectæ, are to be interpreted as the umbrella of a primary medusoid person. The metabracteæ or *secondary covering pieces*, however, which usually cover the stem of the Physonectæ in large numbers, may have various phylogenetic origins. They may arise as—

(1) Displaced umbrellas of secondary medusomes;

(2) Vicariæ or multiplied reserve-bracts of the same;

(3) Cleft portions of divided (*e.g.*, quadripartite) umbrellas.

The direct transition of nectophores into bracts is to be observed among the Physonectæ in the Athoridæ and Anthophysidæ. In *Athoria* and *Rhodophysa*, I find in the distal portion of each bract a small rudimentary nectosac or swimming cavity, sometimes with four cnidonodes or stinging knobs, which may be regarded as the rudiments of four reduced tentacles. The highest and most manifold development of bracts is found in the Calyconectæ, where the sterile medusome of each single cormidium bears a large hydrophyllium of a peculiar form, often characteristic of the genus. The phyllocyst, too, or the canal of the bract, here often exhibits several apophyses, which may be regarded as rudimentary radial canals of the umbrella; *e.g.*, *Aglaisma*, the free Eudoxia of *Calpe*, possesses four radial canals in its bract, two paired lateral and two odd sagittal (an ascending and a descending canal).

GONOSTYLES OR REPRODUCTIVE STALKS.

(*Blastostyles, Gonoblastidia, Gonodendra, Klinozooids.*)

The gonophores or the medusiform "reproductive persons" of the Siphonophoræ sometimes develop directly on the stem, that is as buds on the gastral wall of the primary siphon. Such is the case in many monogastric Siphonophoræ, and in several polygastric forms (*e.g.*, in Agalmidæ) with broken-up cormidia. Much more frequently the buds arise from the stomach-wall of secondary polypoid persons, for which we shall use Allman's title of *Gonostyles* or *Blastostyles*. These sacs are usually mouthless, and are described as "tasters," but are better designated sexual palpons. Sometimes (in the Porpitidæ and Velellidæ) these gonopalpons possess a terminal mouth, and may then be called sexual siphons. These sacs frequently branch in a very marked tree-like fashion, so that the numerous gonophores attached to them form large clustered masses (*reproductive-trees, gonodendra*). From a physiological point of view the gonostyles are distinguished both from the palpons and from the siphons very essentially in this, that their sole function is the production of gonophores. From a morphological point of view they may be regarded as sterile Polypo-persons, which are related to their gonophore buds, as the Hydropolyp stock to its medusoid buds (poly-person theory). In this case the succession of generations (*strophogenesis*) would replace the original alternation of generations (*metagenesis*). According to the poly-organ theory, on the other hand, each gonostyle is only to be regarded as an organ, corresponding to a Medusa-manubrium, from which sexual medusoid persons of the next generation arise by budding.

GONOPHORES OR REPRODUCTIVE PERSONS.

(*Sexual-Medusoids, Gonozooids.*)

Among all parts of the Siphonophoral organism, the gonophores are always those members which most distinctly preserve the original character of the medusoid person. The two principal organs, the *umbrella* and the *manubrium*, are always present. In the wall of the latter the generative products arise. But only in the Disconectæ (and perhaps in a number of Cystonectæ) does the oral aperture of the manubrium appear to break through; in the others it remains closed. The reproductive cells arise in both sexes of the Siphonanthæ from the entire surface of the manubrium (as in the Codonidæ), and indeed from the exoderm. The umbrella of the gonophores has the velum and the circular canal of the umbrellar margin usually well preserved, and the same is true

of the four radial canals of the subumbrella. Only rarely do these portions become more or less rudimentary, so that the medusoid form is lost and passes over into a more or less degenerate "sporosac." The tentacles on the umbrellar margin of the gonophores have usually disappeared; sometimes, however (as in some Calyconectæ), four rudiments are recognisable, and at other times even a corona of tentacular rudiments (*Desmophyes*). The Disconanthæ, in which free reproductive Medusæ in the sexually mature state are not yet sufficiently known, may perhaps bud off four or eight separate gonads either from the manubrium, or from the subumbrella.

As to the distribution of the two kinds of gonophores on the corm, it must be noticed that most of the Siphonophoræ are monœcious. Some Calyconectæ (*Mitrophyes, Galeolaria*) and some Physonectæ (*Apolemia, Athoralia*) are diœcious. Among the monœcious corms both kinds of sexual persons occur, sometimes in separate cormidia (diclinous), sometimes associated in each single cormidium (monoclinous). The gonodendra, or the clustered groups of gonophores, are usually distylic, all their branches bearing Medusæ of the same sex; male and female gonodendra arising separately. But sometimes there are monostylic gonodendra, the basal part of the single branched gonostyle bearing female, and the distal part male, gonophores (as in the Auronectæ and Cystonectæ, *Forskalia*, &c.). On the other hand, hermaphrodite persons (*i.e.*, gonophores which form both spermatozoa and ova) are not known in this class. The male persons are known as androphores, the female as gynophores. Usually the androphores are slender, more oblong, and bear a spindle-shaped or cylindrical spermarium; the gynophores are thicker, more rounded, and bear an ovate or ellipsoidal ovarium.

FUNDAMENTAL FORM (PROMORPH).

The promorphology of the Siphonophoræ has led to very different views respecting the ideal geometrical fundamental form (or the "promorph"), which may be recognised by abstraction from the concrete single forms of these Acalephs. One group of authors regards the Siphonophoræ as "*Radiate animals*," whilst another group maintains that they are "*Bilateral animals*." These opposed views are both right in a certain sense. On the one hand, a typical *radial structure*—generally a quadriradial form, composed of four equal quadrants—is recognisable in all Siphonophoræ (mainly in the gonophores and nectophores), and this is in my opinion produced by inheritance from the older ancestral Medusæ. On the other hand, a distinct *bilateral structure*—or a dipleural fundamental form, composed of two symmetrical halves or antimeres—is recognisable in most Siphonophoræ, viz., in all Siphonanthæ, whilst it is wanting in the Disconanthæ. This bilateral type is partly inherited from the bilateral Medusæ, which we regard as the ancestors of the Siphonanthæ (Protomeda), and the essential form of

which is preserved in the bilateral larva, Siphonula; but partly the bilateral type is produced by adaptation, and mainly by accommodation to the conditions of development of the single forms. In order to get a clear conception of these difficult promorphological relations, we must distinguish, firstly, the fundamental forms of the entire cormus and of the single persons or medusomes composing it; and secondly, the different promorphological development in the two independent legions of the class, the Disconanthæ and the Siphonanthæ.

The promorph of the single medusome has the quadriradial medusoid type usually clearly expressed, when the umbrella is well preserved, as in the gonophores and nectophores (always with four radial canals and a connecting marginal ring-canal). But also in other parts of the medusomes the radial promorph may be recognised, as in those siphons which possess four, eight, or sixteen hepatic stripes, mouth lobes, &c.

Promorph of the Corms in the Disconanthæ.—The ideal geometrical fundamental form exhibits in the colonies of Disconanthæ two different types; one of these, represented by the Discalidæ and Porpitidæ, is the primary and original type; the other, exhibited by the Velellidæ, is a secondary modification. All corms of Discalidæ (Pls. XLIX., L.) and of Porpitidæ (Pls. XLV.–XLVIII.) preserve a completely regular octoradial structure; their ideal promorph is a regular octagonal pyramid. The vertical main axis of this pyramid, around which the eight equal parameres are regularly arranged, bears at its superior or apical pole the apical stigma of the central chamber of the pneumatocyst, at its inferior or basal pole the mouth of the central siphon. The eight equal sides of the pyramid are represented by the eight triangular radial chambers of the pneumatocyst, whilst the eight perradial grooves between these, and the eight canals running in the grooves, further the eight primary tentacles at the distal end of the canals, mark the eight edges of the pyramid. The horizontal lines which connect these edges with the vertical main axis are opposed in four pairs, and represent the four primary or perradial cross-axes of the octagonal pyramid; whilst the four secondary transverse axes alternating with these, and bisecting the eight triangular radial girdle-chambers of the pneumatocyst, are interradial. The perfectly regular octoradial promorph, which is so clearly marked by the structure of the central pneumatocyst, is likewise expressed by the entire structure of the canal-system, the eight primary perradial canals of the exumbrella, the centradenia, the subumbrella, &c., by the regular octoradial corona of the eight primary tentacles and gonostyles, the eight gastral ostia in the fundus of the central siphon, the eight lappets of its mouth, &c. The young larva of all Discalidæ and Porpitidæ (Disconula, Pl. L. figs. 9, 10), and the simplest permanent genus of this legion (*Discalia*, Pl. XLIX.), exhibit the octoradial type in the same complete regularity as any octoradial Medusa (*e.g., Trachynema, Pectyllis*).

The Velellidæ (Pls. XLIII., XLIV.) differ from the regularly octoradial Porpitidæ and Discalidæ in the amphithect modification of the promorph, which is usually called

"bilateral," sometimes even "uniradial" (Chun). But a comparative study of their development, and mainly of the central part of their body, demonstrates that the corm of all Velellidæ originally is also octoradial; this is clearly proved by the girdle of eight radial lobes which surrounds the central chamber of the pneumatocyst; further, by the eight primary radial canals, which arise from the gastrobasis of the central siphon and give off the ascending branches forming an octoradial liver-star on the upper surface of the centradenia. *Rataria* (Pl. XLIV.), as the simplest form of this family, and the similar Ratarula-larvæ of other Velellidæ, possess marks of an octoradial type also in other organs (eight primary buds of gonostyles, sixteen primary tentacles, &c.). But whilst the eight parameres in the Discalidæ and Porpitidæ are precisely equal (each composed of two symmetrical antimeres), they are unequal in the Velellidæ (each composed of two asymmetrical antimeres). The two horizontal cross-axes, which are perpendicular one to another, and to the vertical main axis, are both equal in the Discalidæ and Porpitidæ; whilst they are unequal in the Velellidæ. Their sagittal axis (marked by the vertical sail) is longer than the frontal axis (marked by the transverse groove of the pneumatocyst). But the dorsal half of the corm (on one side of this frontal groove) is symmetrically equal to the ventral half (on the opposite side), in the same manner as the right half is symmetrically equal to the left (separated from it by the vertical sail). The fundamental form of the corm in the Velellidæ, therefore, is not "bilaterally-symmetrical," but "amphithect," or bilaterally-octoradial, similar to that of the Ctenophoræ.

The octoradial structure of the Medusæ is originally derived from the quadriradial type, as I have demonstrated in my Monograph of the Medusæ. The same promorphological law is valid also for the Disconectæ. Their octoradial trunk has arisen from the umbrella of some Medusa, the older ancestors of which were quadriradial. Their next ancestral forms may be Trachynemidæ, with eight radial canals, eight tentacles, &c. But these again have arisen from the older Petasidæ, which possess four radial canals, four tentacles, &c. This older quadriradial structure is still preserved in the medusiform gonophores of the Disconectæ (*Discomitra*).

Promorph of the Corms in the Siphonanthæ.—The corm of the Siphonanthæ, differing from that of the Disconanthæ in all respects from the first beginning, is also distinguished completely by its bilateral promorph. The primary larva (Siphonula), which develops the corm of the Siphonanthæ by unilateral budding from its manubrium, has already a markedly bilateral fundamental form. Its primary umbrella has a deep ventral cleft, and its only tentacle is attached to one side of the manubrium. The vertical plane, which passes through the median line of these parts, is the sagittal plane, and bisects the entire body; the two halves separated by it, right and left, are symmetrically equal. That side of the manubrium from which arise the buds of the corm is the ventral side, the opposite the dorsal side.

In order to get a clear conception of the bilateral promorph of the Siphonanthæ (very unnaturally described by many authors), it is very important to distinguish the three primary dimensive axes, and to compare them with those of man or of some other bilaterally symmetrical animal. The first or principal is the vertical main axis, the longitudinal axis of the tubular stem; its upper or apical pole bears the pneumatophore in the majority of Siphonanthæ, the primary nectophore in the Calyconectæ. The opposite end is the lower or basal pole.

The second dimensive axis is the sagittal diameter; its ventral or anterior pole is marked by the series of buds, and usually by a ventral groove of the tubular stem. The opposite dorsal pole is distinguished in the Auronectæ by the aurophore, in *Physalia* by the crest of the pneumatocyst. The vertical plane, which is determined by the sagittal and the principal axes, perpendicular one to another, is the median or sagittal plane; it separates the right and left halves of the body.

The distinction between right and left halves (often confounded by different authors, and described in striking contradiction) is always clear, when the ventral side is constantly defined in the same sense as that side of the body from which the buds arise. Therefore, the two poles of the frontal diameter, or the third dimensive axis (right and left pole), must be always the same. In the monogastric Calyconectæ, for instance (*Eudoxia*, &c.), the single siphon is placed on the ventral side of the bract (or the modified umbrella); in the polygastric Calyconectæ, correspondingly, the trunk is placed on the ventral side of the first or proximal nectophore (the nectosarc, therefore, on its dorsal side). In the Diphyidæ, the ventral sides of the two nectophores are opposed one to another.

The bilateral promorph of the Siphonanthæ is at the same time quadriradial (or by duplication of the parameres octoradial). This radial structure, inherited from the ancestral quadriradial Medusæ, is not only evident in the four radial canals of the gonophores and nectophores, the eight hepatic stripes and mouth-lobes of many siphons, &c., but also in the structure of the primary larval umbrella, and the pneumatophore arising from it. The majority of the Siphonanthæ exhibit in the basal part of the pneumatosaccus eight (more rarely four or sixteen) radial pouches, which are separated by vertical septa and comparable to the radial canals of a Medusa.

DESCRIPTION OF THE FAMILIES, GENERA, AND SPECIES.

SIPHONOPHORÆ.

Definition of the Class.—The Siphonophoræ are swimming colonies or corms of Hydromedusæ, composed of polymorphous medusoid zooids or persons, which arise by budding from an original simple Medusa. The class is divided into two subclasses :—the DISCONANTHÆ arise by budding from the subumbrella, the SIPHONANTHÆ by budding from the manubrium of the original Medusa. The Disconanthæ comprise one order only (Disconectæ); the Siphonanthæ comprise four orders—Calyconectæ, Physonectæ, Auronectæ, Cystonectæ.

Synopsis of the Five Orders of Siphonophoræ.

I. DISCONANTHÆ: Truncus or cœnosome formed by the umbrella of the original octoradial Medusa, which includes a polythalamous pneumatocyst; the buds arise in concentric girdles from the subumbrella. Larva octoradial (Disconula), . 1. DISCONECTÆ.

II. SIPHONANTHÆ. Truncus or cœnosome formed by the manubrium of the original bilateral Medusa; the buds arise in the ventral line of the manubrium. Larva bilateral (Siphonula).

- No pneumatocyst or float filled by air. No palpons. Always one or more nectophores are present, . . 2. CALYCONECTÆ.
- A monothalamous pneumatocyst or a float filled with air is always present.
  - With nectophores or with bracts (often both together present). With palpons.
    - Without aurophore; common stem thin, tubular, with a simple canal, . 3. PHYSONECTÆ.
    - With an aurophore; common stem thick, bulbous, with a network of canals, . 4. AURONECTÆ.
  - Without nectophores, and without bracts. Pneumatocyst with an apical stigma, . 5. CYSTONECTÆ.

Subclass I. DISCONANTHÆ.

Order I. DISCONECTÆ, Haeckel, 1888.
(Pls. XLIII. to L.).

Chondrophoræ, Chamisso, 1821, **16**,[1] p. 363.
Velellidæ, Eschscholtz, 1829, **1**, p. 165.
Cirrhigradæ, Blainville, 1834, **24**, p. 303.
Porpitariæ, Haeckel, 1869, MS. Canar.

Definition.—Siphonophoræ with a permanent primary umbrella, without nectophores and bracts. Nectosome campanulate, lenticular or discoidal, including a polythalamous, originally octoradial pneumatocyst, which exhibits numerous stigmata on its upper face, and tracheæ on its lower face. Siphosome composed of a central primary siphon, and one or more concentric girdles of gonostyles (either secondary siphons, or instead of these palpons), the latter producing gonophores. The primary larva (Disconula) has a regular octoradial umbrella, with eight radial canals and a connecting circular canal at the margin, which bears eight primary radial tentacles.

The order Disconectæ comprises three families, the Discalidæ, Porpitidæ, and Velellidæ; all members of this order agree in so many important characters, and differ so widely from all the other Siphonophoræ, that I divide the whole class into two subclasses, Disconanthæ and Siphonanthæ. The first subclass, Disconanthæ, represented by the Disconectæ only, is developed from the octoradial and octonemal medusoid larva Disconula; it retains the primary corona of eight or more marginal tentacles, possesses a centradenia, and produces the polymorphous persons by budding from the subumbrella. The second subclass, Siphonanthæ, on the other hand, represented by four orders (Calyconectæ, Physonectæ, Auronectæ, and Cystonectæ), differs in the bilateral form of its mononemal larva, Siphonula; this, as well as each of the following siphons, has only a single tentacle; the centradenia is wanting, and the polymorphous persons of the cormus bud in the ventral line of the primary siphon.

History.—Eschscholtz, in his fundamental work,[2] separated from the other Siphonophoræ the family Velellidæ, comprising the genera *Porpita* and *Velella* of Lamarck (1815). So early as 1821 these were united as "Medusæ chondrophoræ" by Chamisso and Eysenhardt. Eschscholtz added as a third genus *Rataria*, and found the peculiar character of all Velellidæ in the possession of an internal polythalamous cartilaginous shell, the chambers of which are filled with air. Brandt afterwards (in 1835, **25**) separated the Porpitidæ (with circular shell, without vertical crest) from the true Velellidæ

[1] The figures in black type refer to the Bibliography at the end of the Report.
[2] System der Acalephen, 1829, p. 165, (1).

(with elliptical or oblong shell, and a vertical crest). Huxley (in 1859) gave the first accurate definition of this group (9, p. 71):—"Physophoridæ without nectocalyces or hydrophyllia; with short, clavate, simple or branched, submarginal tentacles. A single central principal polypite. Pneumatocyst flattened, divided into chambers by numerous concentric partitions, and occupying almost the whole of the discoidal cœnosarc." The description which Huxley gave of the two genera *Velella* and *Porpita* is very accurate, as is also that given in 1853 by Kölliker (4). Another description of both has been recently published by Alexander Agassiz (1883, 57). His opinion is that these Siphonophoræ are more nearly allied to the Tubulariæ, and on the other side to the Hydrocorallinæ (Milleporidæ, &c.). The oldest figures are those of Forskål (11).

All authors hitherto agree in the general opinion that the Disconectæ are the most highly developed of all Siphonophoræ, and that they form the terminal group in their systematic arrangement, as being most closely allied to the Physalidæ. In my opinion this general view is quite erroneous. I am convinced, mainly by their ontogeny, that the Disconectæ have preserved the original medusoid structure more than any other Siphonophoræ (or the Siphonanthæ). They retain the original umbrella with its corona of marginal tentacles, and the original manubrium, which is the "principal polypite," or better, "central siphon." The gonostyles, or the polypiform persons which bear the gonophores (either mouthless palpons or mouth-bearing siphons), bud from the subumbrella (or the lower face of the disc); while the polymorphous persons in all the other Siphonophoræ bud from one side of the manubrium (or the primary siphon) in its ventral line. The primary larva of all the Disconectæ (Disconula) is a regular octoradial Medusa, with a marginal corona of eight radial tentacles, widely different from the larva of all other Siphonophoræ (the Siphonula, with bilateral umbrella and a single tentacle). I suppose, therefore, that there is no direct relation between the Disconanthæ and the Siphonanthæ, and that the two subclasses or legions have a different origin: the former arising from Anthomedusæ (Codonidæ, Euphysidæ), the latter from Trachomedusæ (Trachynemidæ, Pectyllidæ).

Nectosome and Siphosome.—The two main parts of the fully-developed body, which we separate as nectosome (or swimming apparatus) and siphosome (or nutritive apparatus), have in the Disconectæ a mutual relation very different from that of the other Siphonophoræ (the Siphonanthæ). The *nectosome* is represented by the *exumbrella*, or the upper half of the discoidal body, which includes the polythalamous pneumatocyst; the *siphosome*, however, is formed by the *subumbrella*, or the lower half of the horizontal disc, and by the different organs which are attached to its margin and to its lower face. The boundary face between the two main parts is the upper face of the centradenia or the so-called "liver"; it is in close contact with the lower face of the pneumatosaccus. The constant organs, which depend from the subumbrella, are the following:—(I.) The large central siphon, in the middle of the lower face; (II.) a simple or multiple corona

of gonostyles, which bear the gonophores (mouthless palpons in the Discalidæ, mouth-bearing siphons in the Porpitidæ and Velellidæ); (III.) a simple or multiple corona of submarginal tentacles.

Umbrella.—That part of the body, which is the true homologue of the umbrella in the common Medusæ, is in the Disconectæ the most voluminous part of the whole cormus. It includes the polythalamous pneumatocyst, and bears all the other organs on its lower face. The latter corresponds to the subumbrella of the typical Medusæ, while the upper face is homologous with their exumbrella. Both faces are separated by the peripheral margin or limb of the umbrella, which constantly bears a corona of muciparous glands. The exodermal epithelium of the umbrella everywhere includes scattered nematocysts. Beyond it there is a nervous plate, mainly developed on the limb and the upper face. The muscles of the umbrella are more developed on the upper than on the lower face; they are composed of an outer layer of longitudinal or radial fibres, and an inner layer of transverse or circular fibres.

Exumbrella.—The superior (apical or proximal) part of the umbrella, which is separated from the inferior part (or subumbrella) by the glandiferous limb, is sometimes a nearly even horizontal disc, at other times more or less convex. Its upper free face is either smooth or papillate, always pierced by stigmata; its lower face is in contact with the centradenia. The exumbrella in all Disconectæ is composed of two parallel plates, which are separated by the reticulate plexus of the pallial canals; the outer plate is the pneumatocodon, the inner is the pneumatosaccus.

Pneumatophore.—The hydrostatic apparatus, or the swimming-bladder, which we call pneumatophore, has in the Disconectæ another and a far more complicated structure than in all the other Siphonophoræ (or the Siphonanthæ). Only the first beginning can be common to the two subclasses, viz., a simple pneumadenia, or a gas-producing gland of the exumbrella. But this is centrally placed in the Disconanthæ, excentrically in the Siphonanthæ; and further, the chitinous pneumatocyst, which covers the inside of the pneumadenia, is a simple monothalamous cyst in the latter, a multiple polythalamous cyst in the former. Another important difference is furnished by the openings of the pneumatocyst; the simple pneumatocyst of the Siphonanthæ is either closed, or has only a simple opening (infundibulum) at the lower pole, and another simple mouth (stigma) on the upper pole of its main axis. The polythalamous pneumatocyst of the Disconanthæ, however, has numerous openings on both faces, internal tracheæ on the lower face, external stigmata on the upper face.

Pneumatocodon.—The pneumatophore as a whole, or the hydrostatic apparatus, is composed of all the above-mentioned parts, and of the two plates of the exumbrella also already referred to. The outer or upper of these is the pneumatocodon, the uppermost lamella of the entire umbrella. It is composed of three layers, an outer exodermal epithelium, a nervous plate (composed of a loose reticulum of branched ganglion cells),

and a double muscle plate, with outer radial and inner circular fibres. The plexus of pallial canals separates the pneumatocodon from the pneumatosaccus.

Pneumatosaccus.—That lamella of the exoderm which surrounds immediately the chitinous pneumatocyst, is the pneumatosaccus. It represents the invaginated part of the exumbrella, and has taken its origin from a simple bottle-shaped gland in its apex. This gas-secreting gland—or pneumadenia—originally small and occupying only the apical centre of the exumbrella, has afterwards become so extraordinarily expanded that it usually forms the most voluminous part of the entire umbrella. The exodermal epithelium of the pneumatosaccus is a simple stratum of glandular cells, which secrete the cuticular chitinous plate of the adjacent pneumatocyst. The basal part, or the inferior face of the former, is probably also the matrix of the centradenia or the so-called "liver." The exodermal cells, and cnidoblasts, which constitute the solid parenchyma of the latter, are probably derived from the basal part of the pneumatosaccus.

Pneumatocystis.—The chitinous polythalamous float filled with air, which we call pneumatocyst (formerly called "inner shell"), exhibits in all Disconectæ a rather complicated structure. Its general form is circular, and originally octoradial in the Discalidæ and Porpitidæ, elliptical or nearly quadrangular (parallelogram) in the Velellidæ; but also in the young larvæ of the latter its first rudiment is octoradial. It always commences with the formation of a simple central chamber, which is situated in the centre of the exumbrella, just above the gastral base of the large central siphon. It opens outside by a central stigma in its upper face. Around this primary central chamber (the chitinous lining of a central pneumadenia of the exumbrella) a peripheral corona of eight radial chambers is next formed, each provided with an outer stigma on its upper side, and with an articulate trachea on its lower side. These eight radial chambers are equal and regularly radial in the Discalidæ and Porpitidæ, while they are more or less amphithect and somewhat bilaterally disposed in the Velellidæ. Sometimes in the latter family they are more or less obliterated.

In the simplest case (*Discalia*, Pl. XLIX.) the formation of the pneumatocyst is complete with the eight radial chambers; in all the other Disconectæ a different number of peripheral concentric chambers is formed around their octoradial corona. All these tertiary chambers are simple rings without radial partitions; they open outside (in the exumbrella) by a different number of stigmata, inside (in the centradenia) by a number of open tracheæ. The rings are circular in the Discalidæ and Porpitidæ, elliptical or quadrangular (parallelogram) in the Velellidæ. In these latter there usually arises afterwards a solid vertical crest, placed diagonally on the upper side of the horizontal disc.

The general opinion regarding the physiological function of the polythalamous pneumatocyst of the Disconectæ may be summed up in the following propositions:—(1) The Disconectæ are exclusively pelagic animals, always floating on the top of the ocean, and never sinking below its surface; (2) the air contained in the pneumatocyst is atmo-

spheric air, taken in by the stigmata of the exumbrella; (3) this air is conducted through the respiratory tracheæ to the different appendices of the subumbrella (central siphon and gonostyles); (4) the distal or lower ends of the tracheæ are closed.

The observations which I have myself been able to make on the structure and function of the pneumatophore in the different groups of Disconectæ have conducted me to quite opposite views, viz.,—(1) The Disconectæ are (all or partly) capable of sinking under water, by muscular compression of the pneumatocyst, and expulsion of air by the stigmata of the exumbrella. (2) The air contained in the pneumatocyst is not atmospheric air taken in by the stigmata, but a gas produced by the exodermal cells of the great "central pneumadenia" (the so-called "liver" or central organ). (3) This gas, therefore, has not respiratory, but hydrostatic functions (like the gas in the swimming-bladder of the fishes). (4) The distal or lower ends of the tracheæ are not closed by a chitinous plate, but open into the glandular, gas-secreting, exodermal tissue of the centradenia; they are comparable to the "pylorus infundibuli" of the Siphonanthæ.

Central Siphon.—The large central polypite, which is placed in the centre of the subumbrella in all Disconectæ, is the original manubrium of the primary medusiform larva (Disconula); its terminal mouth is the permanent primary mouth of the latter. The central siphon is the only organ of feeding and digesting in the monogastric family Discalidæ, whilst in the other two families of the order, the polygastric Porpitidæ and Velellidæ, this function is also executed by the numerous peripheral gonostyles, which are here developed in the form of mouth-bearing siphons or secondary polypites. But also in the young monogastric larvæ of these latter, the primary central siphon is alone provided with a mouth. Its size is very variable in the different Disconectæ; generally it is comparatively large in the small Discalidæ, and in the smaller forms of Porpitidæ and Velellidæ, which possess few secondary siphons; on the other hand, it is relatively small in the larger forms of the two latter families, which possess a great number of feeding peripheral polypites.

The form of the central siphon in the Discalidæ and Porpitidæ is inversely conical, with circular transverse section; whereas in the Velellidæ the inverted cone is strongly compressed from both sides, so as to be elliptical or lanceolate in transverse section. The wider proximal or upper part, or the true stomach, passes without a sharp boundary into the cylindrical, very contractile, distal or lower part, the proboscis. The latter, as well as its distal opening, the mouth, is very variable in size and form, according to its state of contraction.

The surface of the central siphon exhibits in many Disconectæ a number of longitudinal or radial folds, visible partly outside, partly inside; usually there are eight or sixteen, sometimes more. The distal mouth correspondingly often exhibits eight or sixteen lobes, sometimes also four larger lobes; at other times it is simply circular, or

in the Velellidæ elliptical. In the expanded state the mouth may assume the most different forms, trumpet-shaped, discoidal, &c.

The thick wall of the central siphon is always very contractile, and composed of five layers:—(1) An outer epithelium or epidermis, rich in cnidocysts; (2) a very thick layer of strong longitudinal muscles; (3) a solid fulcrum or a homogenous structureless elastic supporting plate; (4) a thin layer of circular muscles; (5) an inner epithelium or entoderm. The mouth is armed with peculiar cnidocysts and provided with sensillæ. The upper or proximal half of the central siphon contains in its epidermis often (but not always) a number of bent tracheæ, which end here.

Gastrobasal Plate.—The basal or proximal part of the central siphon in all Disconectæ is separated from the superjacent centradenia by a strong fulcrum, or a structureless elastic supporting plate (*lamina gastrobasalis*). This horizontal fulcral plate (also called the roof of the central polypite, "le plancher" of Bedot, **59, 60**) is covered on the upper face by the basal surface of the centradenia, on the lower face by the entodermal epithelium of the stomach. It corresponds to the jelly-plate which forms the roof of the manubrium in the Medusæ. Its central part is solid, whilst its peripheral part is pierced by eight or more gastral ostia; these form an octoradial corona in the Discalidæ and the smaller Porpitidæ, whilst their number is increased in the larger forms of the latter family (sixteen to thirty-two or more). Sometimes the numerous ostia form here vertical lanceolate fissures, and the septa between them form an elegant multiradiate star, composed of numerous vertical lamellæ. The Velellidæ exhibit instead of this regular star a bilateral arrangement of the gastral ostia; they form here two opposite longitudinal rows of fissures (usually sixteen) on the two lateral margins of the lanceolate gastrobasal plate.

Centradenia or Central Gland.—The central space of the body, between the apical or proximal pneumatophore and the basal or distal central siphon, is in all Disconectæ occupied by a peculiar large glandular organ, wanting in all the other Siphonophoræ (or Siphonanthæ). This interposed central organ is usually called the liver (*hepar*); but as its structure and function are complicated and not merely hepatic, it may be better called *centradenia*, or central gland. It is composed essentially of a dense network of entodermal gastral canals, and of a compact parenchyma of exodermal epithelium, with innumerable cnidoblasts, filling up the meshes or intervals of that network. The physiological function of the gastral canals may be partly hepatic (digestive), partly renal (excretory); the exodermal epithelium, however, seems partly to perform the function of a pneumadenia (or gas-producing gland), partly to be a large reservoir of cnidoblasts for other purposes.

The Form of the Centradenia is in general lenticular or discoidal, sometimes subglobular or even cylindrical, sometimes more conical or flatly expanded; its peripheral outline is circular, or sometimes regularly octagonal, in the Discalidæ and Porpitidæ; it

is elliptical or sometimes lanceolate in the Velellidæ; often the periphery is more or less lobate, corresponding to the form of the surrounding peripheral part of the umbrella. The upper or proximal surface of the centradenia is attached to the lower or distal surface of the pneumatosaccus, and separated from it by a thinner or thicker fulcrum, a firm and elastic, structureless, supporting plate. But this supporting septum is wanting in the young larvæ, where the exodermal epithelium of the pneumatosac is in immediate contact and connection with the upper face of the centradenia.

All the various and often complicated apophyses (radial ribs, circular rings, &c.) which are formed by the distal or inferior face of the pneumatocyst, and its enveloping pneumatosac, are surrounded by corresponding furrows or envelopes of the proximal or superior face of the centradenia; the latter being always immediately attached to the supporting plate, which separates it from the former in the adult Disconectæ.

The lower or distal surface of the centradenia is in its central part in contact with the base of the central siphon, in its peripheral part with that portion of the subumbrella which bears the gonostyles. The fundus of the central siphon, or the uppermost part of its cavity, is separated from the attached centradenia by a strong support, that supporting plate, which has been described above as "lamina gastrobasalis." This elastic and structureless plate is pierced in the periphery of the basal part of the stomach by eight or sixteen (sometimes more) radial canals, which arise from the fundus of the stomach itself and pass into the vascular system of the centradenia. We call these the primary perradial gastro-canals. There are originally eight equal and regularly disposed radial canals in the Discalidæ and Porpitidæ. In the Velellidæ, on the other hand, they are arranged in a bilateral manner; two larger radial canals (a dorsal and a ventral) arising from the opposite poles of the longer (sagittal) axis, two smaller (right and left) from the poles of the shorter (transverse) axis, and four other (diagonal) canals in the middle between the latter and the former. But usually the number of intercalated secondary canals is here much larger, and their arrangement more or less irregular.

Origin of the Centradenia.—For the right understanding of this peculiar organ of the Disconectæ, a knowledge of its origin and development is essential. This question may be solved by the comparison of very young Disconectæ and mainly of the Discalidæ. These simplest and most primitive Disconectæ remain permanently in a lower stage of development, which is transitory in the Porpitidæ and Velellidæ. In the smallest Disconula-larvæ which I observed the centradenia is a small circular, biconvex, lenticular disc; its upper face is in direct contact with the pneumatosaccus, whilst its lower face is separated from the central siphon by the gastrobasal plate ("plancher" of Bedot). The entire mass of this solid disc is composed solely of exodermal cells and cnidoblasts; it is not traversed by any canals. The only canals of the centradenia are the eight simple radial canals which run upon its upper face; they arise from the eight ostia of the basigaster, embrace the surface of the lenticular centradenia like eight meridian lines, and

unite in the centre of its upper face, forming a typical octoradial "liver star." This is quite regular in the youngest Discalidæ and Porpitidæ; it is amphithect in the young Velellidæ, where the two opposite canals of the sagittal axis are larger than the six others, three right and three left (compare Bedot, **60**, pl. ix. figs. 1, 2).

These eight primary liver-canals, running between upper face of the centradenia and lower face of the pneumatosaccus, must be regarded originally as ascending branches of the eight primary radial canals of the subumbrella, which run from the basigaster towards the peripheral limb. All the numerous canals (partly hepatic, partly renal vessels) which traverse the centradenia of the larger Disconectæ in all directions, and form a complicated network, are merely secondary branches and ramifications of those eight superficial canals of the primary "liver-star." They seem to be disposed and differentiated in a variable manner. The majority of Disconectæ exhibit in the adult state a superior system of hepatic vessels (characterised by production of brown or blackish pigment granules) and an inferior system of renal vessels (characterised by the production of greenish guanin-crystals), the so-called "white plate" of its discoverer, Kölliker.[1]

The cnidoblasts and the intermingled matter, indifferent or interstitial cells of the exoderm, which, densely aggregated, constitute the solid glandular parenchyma of the centradenia, doubtless have their origin in the exoderm. But the locality of their origin, or the point of their exit between the central siphon and pneumatosaccus, has hitherto been doubtful. Bedot, who has given the best and most accurate histological description of the "central organ" of the Velellidæ (**58–61**), assumes that the place of their origin is the subumbrella. According to his description,[2] a number of subumbral exoderm-cells immigrate into the interior, passing through numerous pores of the subumbrellar support (his "lamelle aniste externe," *loc. cit.*). These pores possess, in my opinion, a secondary importance, and are perhaps artificial openings.

It seems to me much more probable that the exodermal cells of the centradenial parenchyma may be derived from the basal or inferior part of the pneumatosaccus, *i.e.*, that invaginated lamella of the exumbrellar exoderma which encloses and produces the chitinous pneumatocyst ("couche cellulaire qui tapisse le pneumatophore"[3]). This important part of the pneumatosac is, in young Disconectæ, in immediate contact with the upper face of the centradenia, as Bedot himself has demonstrated.[4] The structureless support, which separates the two organs in the adult ("lamelle aniste interne" of Bedot, *loc. cit.*, p. 238), is not yet formed. This, in my opinion, is right, and the constituting exodermal cells of the centradenial parenchyma are derived from the exumbrellar invagination of the pneumatosaccus; they may be compared to the glandular gas-secreting cells of the "infundibulum pneumatophori" of the Siphonanthæ. I have very often found in well-preserved specimens the cnidoblasts of the centradenia filled with an air-bubble, and

[1] Kölliker, **4**, p. 59.
[2] Bedot, **59**, p. 503, pl. xxv. figs. 4 *le*, 8 *o*.
[3] Bedot, **59**, pl. xxv. figs. 4, 5 *in*.
[4] Bedot, **60**, p. 238, pl. ix. fig. 2.

this seems to confirm my opinion that the centradenia is not only a hepatic and a renal, but at the same time a gas-secreting gland.

Canal System.—The system of gastral vessels or entodermal canals is in the Disconectæ very different from that of all the other Siphonophoræ (or the Siphonanthæ); it is far more complicated and exhibits from the beginning quite a different type; it is originally octoradial, determined by eight primary perradial gastral canals, which arise from the periphery of the base of the stomach and correspond to the eight subumbrellar radial canals of a common octoradial Medusa (*Trachynema, Pectyllis*). * This regular, strictly octoradial type is retained through life in the central part of the canal system of all Discalidæ and Porpitidæ, whilst in the amphithect Velellidæ it is found only in early stages, and afterwards becomes bilaterally modified, according to the different growth of the two horizontal cruciate axes. No trace of this octoradial canal system is found in the trunk of any other Siphonophoræ; but a similar type is apparently marked by the octoradial structure of the pneumatosaccus in many Physonectæ.

The peculiar development of the gastro-canals in the umbrella of the Disconectæ is produced, firstly, by the voluminous expansion of the pneumatophore and the invagination of the exumbrella connected with it; and secondly, by the development of the centradenia between the latter and the subumbrella. The following eight parts of the canal system may be distinguished in the most highly developed Disconectæ, as we ascend from the central siphon to the top of the pneumatophore:—(1) The system of subumbrellar radial canals (originally eight), arising from the fundus of the stomach, and running horizontally and centrifugally or ascending in the subumbrella towards the margin of the umbrella; they usually form a complicated network of dichotomously branched radial canals. (2) The marginal canal, which connects the distal ends of the latter; it is placed in the true margin of the umbrella, and corresponds to the circular canal of the Hydromedusæ. (3) The system of renal canals or white excretory vessels, containing green crystals of guanin; it is formed by a network of branches of the subumbrellar canals, which is placed usually in the basal or inferior part of the centrodenia. (4) The system of hepatic canals or brown pigment vessels; it is formed by the apical or superior part of the canal network in the centradenia, in the surface of which it forms a regular octoradial "liver-star." (5) The system of exumbrellar or pallial radial canals (originally eight); these run centripetally and more or less horizontally in the exumbrella towards the centre of the pneumatophore, where they are united by a small ring, surrounding the apical stigma ("mantle-star"); they may be compared to the eight radial pouches of the pneumatophore in many Siphonanthæ. (6) The system of gonostylic cavities, or the gastral cavities of the polyps which bear the gonophores (palpons in the Discalidæ, siphons in the Porpitidæ and Velellidæ); they arise as simple subumbrellar diverticula from the inferior branches of the centradenial system. (7) The canal system of each single gonophore, composed of four radial canals and a connecting ring-canal,

identical with that of a simple Medusa; the central union of the former is connected by a pedicular canal with the gastral cavity of the gonostyle. (8) The system of the tentacular canals or the simple peripheral vessels which arise from the periphery of the subumbrellar system and pass into the tentacles.

Besides these eight parts of the canal system there occurs often (9) a coronal canal, or a horizontal circular ring-canal placed in the coronal groove of the umbrella, between the margin of the pneumatocyst and the centradenia. It represents an inner annular vessel which carries on the circulation in the canals of the centradenia and the subumbrella. The entodermal epithelium exhibits a very different and remarkable shape in these different systems of gastro-canals. The most important seems to be the rich production of black or dark brown bilious granules in the hepatic vessels, and of green guanin crystals in the renal vessels.

Regarding the morphological value of these different parts of the gastro-canal system of the Disconectæ, and comparing them with the corresponding parts of a simple octoradial Medusa (Trachynemida), we may arrive at the following important conclusions:—(1) The eight primary perradial canals, which arise from the base of the stomach (of the central siphon) and run in the subumbrella towards the margin, are homologous with the eight subumbrellar centrifugal radial canals of a simple Trachynemid (*e.g.*, *Pectanthis*). (2) The marginal ring-canal, which connects the former and runs along the limb of the umbrella inside the series of marginal glands, is homologous with the usual marginal canal of a simple Medusa. (3) The tentacular canals, which arise from the subumbrellar canals and pass into the tentacles, are comparable to the tentacular canals of those Medusæ which possess submarginal tentacles (*e.g.*, *Drymonema*). (4) The gonostylar canals, which arise from the subumbrellar canals and pass into the cavity of the gonostyles, are homologous with the cavities of the eight genital sacs of a Trachynemid. (5) The eight centripetal radial canals, which arise from the coronal canal, run in the upper face of the centradenia to its centre and there unite into a "liver star," may be compared to the centripetal canals of the subumbrella of *Carmarina*, *Pectyllis*, and other Trachymedusæ. (6) The coronal canal, or the inner ring-canal, which runs in the coronal groove on the margin of the pneumatocyst, may be compared to the inner ring-canal which develops by anastomoses of the radial canals in some Medusæ.

Whilst these parts of the canal system of the Disconectæ may be compared to corresponding parts of simple Trachymedusæ, there are other parts which are quite peculiar to the former. These secondary productions are:—(1) The pallial system or the anastomosing radial canals of the exumbrella, which form a network on the upper face of the pneumatophore. (2) The internal reticular canal system of the centradenia, forming a hepatic plexus in its upper and a renal plexus in its lower half. The development of the superficial pallial system of canals is a consequence of the invagination of the apical part of the exoderm which produces the pneumatosaccus. The development of the internal

centradenial system of canals, on the other hand, is the consequence of the centripetal immigration of exodermal parenchyma between pneumatosac and gastrobasal plate, producing the centradenia.

The innumerable ramifying and anastomosing branches of the above-mentioned vessels, which form a very complicated network in the majority of Disconectæ, are secondary productions. Their mutual relations are best understood when we compare them with the typical organisation of the simplest forms of that order, *Discalia* and *Disconalia* (Pls. XLIX., L.). The canal system exhibits here three typical octoradial horizontal stars :—(1) The pallial star above the pnoumatocyst; (2) the hepatic star on the upper face of the centradenia; (3) the gastral star below the gastrobasal plate. The eight peripheral main rays of these stars are united by the coronal ring vessel, which runs in the coronal groove around the equator of the umbrella (Pl. XLIX. fig. 4).

Gonostyles.—The sexual persons of the cormus, or the zooids which produce the medusiform gonophores of the Disconectæ, are arranged in a girdle around the base of the central siphon; they occupy a smaller or broader zone of the subumbrella between it and the corona of tentacles (gonostylar zone). These gonostyles or gonoblastidia are mouthless palpons in the Discalidæ, whilst they are either cystons or true siphons, provided with a terminal mouth, in the Porpitidæ and Velellidæ. They are originally nothing else than secondary manubria of a single Medusa person, budding from the radial canals of the subumbrella. They may consequently be regarded as secondary persons, comparable to the buds of the *Gastroblasta* (described by Keller and Lang), and of other Hydromedusæ budding from the subumbrella. On the other hand they may be compared also to the genital sacs which depend from the radial canals of the subumbrella in the Trachynemidæ, Aglauridæ, Pectyllidæ, and in other families of Hydromedusæ. If we imagine that these genital sacs, instead of themselves producing ova and spermatozoa in their exodermal wall, produce by budding Medusæ which afterwards become sexually mature, we shall understand how the Disconectæ have originated from Trachomedusæ.

The mouthless medusiferous palpons of the Discalidæ, and the similar secondary siphons of the Porpitidæ and Velellidæ (differing only in the possession of a mouth at the distal end), have the same structure as the large primary central siphon, but are always much smaller. Their number is originally eight, and they form a regular octoradial corona in some smaller and simpler genera (*Discalia*, Pl. XLIX. figs. 1–4; *Porpalia*, Pl. XLVIII.; *Rataria*, Pl. XLIV.). Sometimes there are sixteen, *e.g.*, in *Disconalia* (Pl. L.) and *Porpitella* (Pl. XLVI.). But usually their number is much increased, and amounts in the larger species to some hundreds. These cover the greatest part of the subumbrella, the large gonostylar zone between the central siphon and the corona of submarginal tentacles, often densely crowded without intervals. The form and size of the gonostyles are very variable, owing to their great contractility. Sometimes they are more spindle-shaped, at other times more cylindrical or pyriform, with a

dilated basal part. Sometimes the proximal half, or the stomach, is separated by a constriction from the distal half or the proboscis. The upper or proximal half only produces by budding the numerous medusiferous gonophores, whilst the distal part, or the contractile proboscis, is armed with cnidonodes. The wall is very contractile, since the longitudinal muscles of the exoderm and the circular muscles of the entoderm are not less developed than in the large central siphon. Sometimes the wall of the gonostyles exhibits eight longitudinal folds or ribs; and often, too, the patches of cnidocysts (or the cnidonodes) are arranged into eight parallel longitudinal rows along the proboscis.[1]

The gastral cavity of the gonostyles opens above into a canal of the subumbrella, or of the centradenia. Its lower or distal end is a closed cæcum in the monogastric Discalidæ, the terminal apex being densely beset with cnidocysts. It opens by a terminal mouth in the Porpitidæ and Velellidæ; this mouth is not less contractile and expansible than the larger mouth of the central siphon. Often the former exhibits four cruciate lips, more rarely eight; sometimes it is circular, without mouth lobes (compare the descriptions of the gonostyles by Kölliker (**4**), Vogt (**5**), Leuckart (**8**), Huxley (**9**), Agassiz (**57**), and others).

Gonophores.—The medusiform gonophores arise from the proximal part of the gonostyles, rarely isolated, usually crowded in smaller or larger groups or bunches. They are in all Disconectæ of the same form, and are detached from the budding gonostyle before coming to sexual maturity. The detached gonophores are very small quadriradial Medusæ of very simple structure. Their subumbrella exhibits four regular radial canals which unite above the velum by a circular canal (compare the above-mentioned authors).

Tentacles.—The limb of the umbrella is in all Disconectæ armed with a corona of tentacles, in the same manner as in all fully-developed Hydromedusæ. They are placed not at the margin itself, but more or less inside, at its lower face, the peripheral zone of the subumbrella. They are, therefore, strictly speaking, submarginal tentacles (such as occur also in some Medusæ, *e.g.*, *Drymonema*). Some authors (Claus, Alexander Agassiz, &c.) regard these organs as self-subsistent persons or zooids, and call them "prehensile polypites," "marginal polypites," "tasters," "dactylozooids," &c. But this conception is quite erroneous, and, in my opinion, there can be no doubt that the submarginal corona of tentacles in the Disconectæ are the same organs as in the common Medusæ, both from a morphological and from a physiological point of view.

Octoradial Corona of Tentacles.—It is a most important fact, not hitherto pointed out as it deserves, that in the larvæ of most Disconectæ there occurs a typical stage, with a corona of eight equidistant and regularly disposed tentacles. They are placed at the distal end of the eight primary radial canals which arise from the base of the central siphon, run along the subumbrella, and are connected round the margin by the circular

[1] Compare **57**, pl. ii. figs. 1–8.

canal; just as in the common octoradial Hydromedusæ (*e.g.*, *Trachynema*, *Rhopalonema*). This regular corona of eight simple radial tentacles is permanent in the simplest and oldest form of the Disconectæ (*Discalia*, Pl. XLIX. figs. 1–4). In all other genera of this order the number of tentacles is rapidly increased, either by interpolation of eight interradial secondary tentacles between the eight perradial primary ones, or by budding of new secondary tentacles on both sides of the base of the primary ones, so that there arise eight bunches of tentacles (*Disconalia*, Pl. L.; *Porpalia*, Pl. XLVIII.). In the larger Porpitidæ their number is afterwards so multiplied, that the margin is armed with a rich corona of many hundreds, or even thousands of tentacles (*Porpema* and *Porpita*, Pls. XLVII. and XLV.). They are here densely crowded, and arranged in concentric girdles (sometimes six to nine or more); the uppermost (or proximal) girdle usually bears the smallest, and the lowermost (or distal) the largest filaments. Their number is much smaller in the Velellidæ, where they form only a single submarginal series in *Rataria* (Pl. XLIV.) and *Velella*, a double (or rarely multiple) series in *Armenista* (Pl. XLIII.). Also in this family the original number seems to be eight, and in some smaller forms are found sixteen; but in consequence of the bilateral development of the umbrella, their number and arrangement is often modified, bilateral, or irregular. In the young larval forms (*Ratarula*) often two primray tentacles, situated at the opposite poles of the major axis (or sagittal diameter) of the elliptic disc, appear earlier than the others; this heterochronism is certainly kenogenetic.

Structure of the Tentacles.—The tentacles of the Disconectæ are very different from those of all other Siphonophoræ; they are relatively short and thick, rather rigid, and their movements are sluggish, as in most Trachomedusæ. In general they are far less extensile and contractile, and do not exhibit that peculiar development and movement which are obvious in most of the Siphonanthæ, and are similar to that of the Anthomedusæ. The body of each tentacle in all Disconectæ is a hollow cylinder with a very strong muscular wall and a narrow canal, closed at the distal end and opening at the proximal end into the annular canal of the margin, or the marginal zone of the canal network. The wall is composed, as usual, of the following five strata, enumerating them from without inwards:—(1) An exodermal epithelium, armed with cnidoblasts, often vibratile in some parts; (2) a strong layer of longitudinal muscles; (3) a thin, but firm and elastic structureless supporting lamella; (4) a thin layer of ring-muscles; (5) a vibratile entodermal epithelium, lining the central canal, composed of very large vacuolate entoderm cells similar to the axial cells in the tentacles of many Trachomedusæ.

The armature of the tentacles with cnidoblasts exhibits characteristic differences in the families of Disconectæ. *Discalia* (Pl. XLIX. figs. 1–4), as the simplest form of all, and likewise probably the youngest larval stages of all Porpitidæ, possess eight simple tentacles, which bear a single cnidosphere (or a spherical knob composed of cnidocysts) at their distal end (Pl. L. fig. 9).

The next larval stage of the Porpitidæ exhibits four stalked cnidospheres at the distal end of each tentacle;[1] one of these is the primary terminal knob, whilst the three others are lateral branches (Pl. L. fig. 10). By multiplication of the latter in the prolonged tentacle arise three longitudinal rows of stalked cnidospheres, one of which is situated on the inferior or distal side of the tentacle, the other two opposite on its two lateral sides. These three longitudinal rows of short lateral branches, each of which bears a spherical cnidonode, are very characteristic of all Porpitidæ; each row bears six to nine or more branches in the larger species, their size decreasing from the terminal (oldest) branch towards the basal (youngest). The basal half of the tentacles is usually simple, and bears no branches.

The tentacles of the Velellidæ are never branched; they always remain simple cylindrical filaments, and are relatively short and small. The cnidocysts are either irregularly scattered on their surface, or form two opposite ribands on the two lateral sides.

Ontogeny.—The individual development of the Disconectæ is very incompletely known, but seems always connected with a peculiar form of metagenesis. The first generation is asexual, the complicated cormus above described producing at its sub-umbrella numerous polypites or secondary manubria (mouthless palpons in the Discalidæ, mouth-bearing siphons in the Porpitidæ and Velellidæ). From the gastral wall of these secondary polypites (surrounding the sterile central siphon) there arise numerous medusiform buds of the form *Discomitra*. These do not become mature whilst sessile and attached to their parents, but are soon detached, and develop into free Hydromedusæ, which produce ova and spermatozoa. Some advanced stages of this second sexual generation are described by Gegenbaur as *Chrysomitra*, and possess eight or sixteen radial canals; but they have not hitherto been sufficiently examined in the adult state. The origin and structure of the sexual organs of the Disconectæ, ovaria as well as spermaria, require a further accurate examination.

It is very probable (though not observed) that from the fertilised egg of this second generation arises a young Medusa with eight radial canals, and that this early produces in the top of its hemispherical umbrella the pneumatocyst, at first a simple central chamber (comparable to the simple pneumatocyst of the Siphonanthæ) and subsequently a corona of eight radial chambers. From this common larval stage probably arise two different lines of individual development. The Discalidæ, on one hand, remain regularly octoradial, and develop eight marginal tentacles (with increasing number), and between these and the central siphon eight or sixteen gonostyles, remaining mouthless palpons. The Porpitidæ retain the same regular octoradial type, but are further developed, and their gonostyles, at first mouthless, acquire afterwards a distal mouth-opening and metamorphose into secondary siphons.

On the other hand, a different course is followed by the bilateral Velellidæ. Here

[1] Compare A. Agassiz, 59, pl. ix. fig. 1.

there arises early a vertical longitudinal fold of the exoderm above the pneumatocyst; and this commencement of the typical vertical sail determines the amphithect or bilateral development of this family; the umbrella becomes elliptical, and the gonostyles bud between central siphon and corona of tentacles, not in concentric circles (as in the Porpitidæ) but in elliptical or oblongish rings. The ontogenetic metamorphosis of these larvæ, developing into the first asexual generation, is not completely known in any Disconectæ. For further particulars regarding the ontogeny reference may be made to the works of Kölliker (4), Vogt (5), Gegenbaur (7), Huxley (9), Pagenstecher (55), Alexander Agassiz (57), and others.

Phylogeny.—The historical or phylogenetic development of the various forms of Siphonophoræ, which we unite in the legion Disconectæ, may be partly recognised from the critical study of their comparative anatomy and ontogeny. By this means I have been conducted to new views of the origin of this interesting subclass, quite different from those of all naturalists who have hitherto treated the question. The general opinion is that the Disconectæ are the most highly developed Siphonophoræ, terminating the series of this class, and most nearly related to the Cystonectæ (Physalidæ). Even the radial chambers of the pneumatophore of the Disconectæ have been often compared to the crista-chambers of the pneumatophore of *Physalia*. This comparison, and all the important consequences deduced from it, are, in my opinion, perfectly erroneous. In direct contradiction to it, I am convinced of the truth of the new theory which I have already shortly explained in my propositions;[1] its principal points are here repeated.

The Disconectæ (or Disconanthæ) have no direct relation to the Siphonanthæ (or all other Siphonophoræ); they have originated, independently of the latter, in a different way and from a different group of Hydromedusæ. Whilst the Siphonanthæ are probably the offspring of the Anthomedusæ (Codonidæ), and their cormus developed by budding from the ventral line of the original siphon, the Disconanthæ, on the other hand, are probably descendants of the Trachomedusæ (Trachynemidæ), and developed by budding from the subumbrella.

The common ancestral group of all Disconectæ is the family Discalidæ (most nearly allied to the Trachynemidæ). From these, probably, the two other families, Porpitidæ and Velellidæ, have been developed as two divergent branches, or, perhaps, the latter have been derived directly from simpler forms of the former family.

Synopsis of the Three Families of Disconectæ.

1. Umbrella circular and regular octoradial. Blastostyles without mouth, .	1. Discalidæ.
2. Umbrella circular, in the centre octoradial. Blastostyles with a mouth, .	2. Porpitidæ.
3. Umbrella elliptical or bilateral. Blastostyles with a mouth, . .	3. Velellidæ.

[1] System der Siphonophoren, Jena, 1888.

Family I. DISCALIDÆ, Haeckel, 1888.

Discalidæ, Hkl., System der Siphonophoren, p. 29.

Definition.—Disconectæ with an octoradial circular permanent umbrella, including a circular, campanulate or discoidal pneumatocyst, without vertical crest. No vertical sail upon the umbrella. Submarginal tentacles of the umbrella simple or branched, with terminal cnidospheres. Central siphon surrounded by numerous mouthless palpons, which bear the medusiform gonophores.

The family Discalidæ comprises some new, small, but very interesting Siphonophoræ from the deep sea, which were found in the collections of the Challenger. They are in general very similar to young Porpitidæ, but differ from them in the very important character, that the large central siphon alone possesses a mouth, while the surrounding gonostyles or blastostyles are mouthless palpons. The Discalidæ are therefore "*Disconectæ monogastricæ*," and become mature in the monogastric state, which is a transitional larval stage in the Porpitidæ. These latter, as well as the Velellidæ, are in the adult state "*Disconectæ polygastricæ*," each gonostyle possessing a mouth and representing a peripheral sexual siphon. The Discalidæ may be regarded as the simplest and most primitive of all Siphonophoræ, since they retain the original character of a simple octoradial Medusa (like *Trachynema* or *Pectyllis*) more nearly than all the others.

Umbrella.—The complete body of all Discalidæ is circular, sometimes more lenticular or discoidal, at other times more campanulate or even subglobular. The vertical or main axis is, therefore, sometimes nearly as great as the horizontal or equatorial axis, at other times scarcely half as great, or even less. The free prominent margin, or the glanduliferous *limbus umbrellæ*, marks the boundary between its upper (apical or proximal) face, the exumbrella, and its lower (basal or distal) face, the subumbrella. The former includes the pneumatophore, and represents with it the *nectosome;* the latter is the *siphosome*, and bears in its centre the large primary sterile siphon, around this numerous sexual palpons (or gonostyles), and towards the margin the corona of tentacles.

A vertical meridional section through the umbrella (Pl. XLIX. fig. 4) demonstrates that the superior half of the umbrella is occupied by the pneumatocyst (*ph*), the inferior by the large centradenia (*uc*), and from this depend in the centre the large central siphon (*sα*), and around it the corona of gonostyles (*gs*). A deep circular coronal groove separates this latter from the corona of submarginal tentacles.

Exumbrella.—The superior (apical or proximal) face of the umbrella is flat or slightly convex, smooth, and pierced by the stigmata of the pneumatocyst. It is composed of two parallel lamellæ, which are separated by the network of the pallial vessels. The external or superior lamella is the pneumatocodon, which contains numerous cnido-

cysts, and (usually) exhibits a distinct octoradial pigment star in its centre (fig. 7). The internal or inferior lamella is the pneumatosaccus, the invaginated plate of the exoderm, which secretes the chitinous pneumatocyst. Its lower face is in contact with the upper face of the centradenia.

Limbus Umbrellæ (Pl. L. figs. 1, 9, *us*).—The free horizontally prominent margin of the umbrella, which separates the exumbrella from the subumbrella, is in all Discalidæ more or less octolobate; the eight interradial convex lobes are the more prominent, the deeper are the eight incisions in which are inserted the marginal tentacles. The whole edge of the mantle-border is beset with a continuous series of marginal muciparous glands.

Subumbrella.—The inferior (basal or distal) face of the umbrella is convex, and bears in its centre the large conical central siphon, around this a corona of gonostyles (eight in *Discalia*, sixteen in *Disconalia*), and in the peripheral part a simple or double corona of tentacles (eight simple tentacles in *Discalia*, Pl. XLIX., eight radial bunches of numerous tentacles in *Disconalia*, Pl. L.).

Pneumatocyst (Pl. XLIX. figs. 4, 5, 8, 9).—The float filled with gas, which is included in the pneumatosaccus, always exhibits in the Discalidæ a regular octoradial structure. This is of typical simplicity in *Discalia* (Pl. XLIX. figs. 2–5), composed only of a subspherical central chamber and a surrounding regular ring of eight equal triangular radial chambers. The more advanced genus, *Disconalia* (figs. 8, 9), exhibits the same biconvex octoradial disc in its central part; but it is here surrounded by a peripheral girdle of five to ten concentric ring-chambers; the middle ones of these are far broader than the innermost and the outermost.

Pneumothyræ.—Each of the eight radial chambers of the central disc of the pneumatocyst communicates with the common central chamber by an inner opening or pneumothyra, placed on the proximal apex of the triangular chamber. Opposite to this lies in the centre of its distal base another pneumothyra, which opens into the first or innermost ring-chamber. An interradial series of similar septal openings, by which every two neighbouring chambers communicate, lies in the centrifugal continuation of the interradial line, which bisects each triangular chamber and connects its apical with its basal pneumothyra. They are, therefore, in *Disconalia* eight regular interradial rows of pneumothyræ (Pl. XLIX. figs. 8, 9, *pg*), and these alternate regularly with the eight perradial grooves which separate the eight triangular chambers from one another, are continued to the peripheral margin of the pneumatocyst, and divide the latter into eight equal triangular octants. The free margin of the pneumatocyst thus becomes distinctly octolobate.

Stigmata (Pl. XLIX. figs. 2, 5, 8, 9).—The superior (apical or proximal) face of the pneumatocyst bears the stigmata or the short tubular openings which pierce the exumbrella and permit an expulsion of the enclosed air. *Discalia* (fig. 2) has only nine stigmata, one central, in the central chamber, and one in each of the surrounding eight radial chambers. In *Disconalia* (figs. 8, 9) this number is increased by a variable number of

accessory stigmata, lying in one or in several of the concentric ring-chambers. Usually the third or fourth only of these exhibit eight stigmata, placed in the interradial lines, which pass through the former. But sometimes these accessory stigmata are irregularly scattered. The gas enclosed in the pneumatocyst may issue by these stigmata, when the strong muscle-plate of the surrounding pneumatosaccus contracts.

Tracheæ (figs. 5, 9, *pt*).—The inferior (basal or distal) face of the pneumatocyst bears the aëriferous tubules which receive the gas secreted by the pneumadenia and conduct it into the chambers of the former. The simplest genus, *Discalia* (fig. 5), possesses only eight short tracheæ, which arise from the peripheral part of the inferior side of the eight triangular radial chambers. The more highly developed *Disconalia* (fig. 9) exhibits, besides these latter, a greater number of peripheral tracheæ, arising from the lower face of the concentric ring-chambers; they are more numerous in the innermost than in the middle ring-chambers, and are wanting in the outermost. Their number amounts to from twenty to eighty or more; their arrangement is variable and irregular. The tracheæ in all Discalidæ are very short and small, their cylindrical articulate tubules composed of ten to thirty small conical segments. They are more or less irregularly curved, and descend in various directions into the solid glandular parenchyma of the centradenia, where their open distal ends are surrounded by exodermal cells. In no Discalidæ do the short tracheæ pierce the entire centradenia and the subjacent gastrobasal plate, nor do they enter into the base of the wall of the central siphon and the gonostyles, as is the case in the Porpitidæ.

Central Siphon.—The large central polypite, which corresponds to the manubrium or gastral tube of the original Medusa, in the Discalidæ is relatively larger and more developed than in the Porpitidæ and Velellidæ. It is in the former the only organ for the reception of food and digestion, whilst these nutritive functions in the two latter families are executed also by the sexual peripheral siphons. The central siphon of the pyriform *Discalia* (Pl. XLIX. figs. 1–4, *sa*) is very elongated, and about as long as the greatest diameter of the umbrella, whilst it is much smaller in the discoidal *Disconalia* (Pl. L. fig. 1); its diameter (in length and breadth) is here only one-third or one-fourth of the latter. The basal part (or stomach) is ovate or pyriform, the distal half (or proboscis) cylindrical. The thick, very contractile wall is composed, as usual, of a stronger exodermal longitudinal layer of muscles, and a thinner entodermal layer of circular muscles, separated by an elastic structureless support.

The fundus of the stomach is separated from the superjacent centradenia by the horizontal gastrobasal plate. The periphery of this solid circular or octagonal support exhibits eight equidistant openings, the ostia, which conduct into the eight radial canals of the subumbrella. These ostia are prolonged sometimes downwards into eight longitudinal grooves at the inside of the stomach, and to these correspond eight longitudinal folds or ribs on its outside.

The mouth or the distal opening of the central siphon is either circular or octagonal, with eight short regular lips or radial mouth lobes (Pl. L. figs. 1, 3). Its edge is strongly armed with cnidocysts.

Centradenia (Pl. XLIX. figs. 4, 10, 11).—The large central gland, which is called the "liver" in the Porpitidæ and Velellidæ, does not exhibit in the Discalidæ the complicated structure seen in those two families, but merely a typical and most instructive simple shape. It is a biconvex lenticular disc of circular or octagonal outline, in *Discalia* (fig. 4) relatively thick and small, in *Disconalia* (fig. 10) broader and flatter. Its horizontal diameter is two to four times as great as its vertical main axis, and of the same length as that of the pneumatocyst above it. Its peripheral margin is surrounded by the corona of gonostyles, whilst its inferior face is in contact with the central siphon.

The entire mass of the lenticular centradenia is composed, in the Discalidæ, of numerous densely aggregated exodermal cells and cnidocysts, and many of these are (in the well-preserved spirit specimens of the Challenger collection) filled with an air-bubble; it is therefore very probable that these cells secrete the gas, which is taken up by the open distal ends of the tracheæ, and conducted by these into the chambers of the pneumatocyst. These gas-producing exodermal cells are probably derived from the basal part of the pneumatosaccus, or the invaginated lamella of the exoderm which includes the pneumatocyst. The thin structureless supporting plate, which separates the upper face of the centradenia from the overlying pneumatosaccus, is pierced by numerous pores which permit a direct connection between the two.

The solid exodermal parenchyma, in the Discalidæ, is only traversed by the tracheæ, and not by the so-called "liver-canals," which form a complex network in the Porpitidæ and Velellidæ. These hepatic canals are here confined to an octoradial "liver-star," which lies in the superior face of the centradenia. The eight main rays of it lie in the eight perradial grooves between the eight interradial triangular air-chambers, and are united in the centre of the lower face of the central chamber. They arise from the basal part of the eight subumbrellar radial canals (near their opening into the base of the central siphon), and embrace the surface of the centradenia like eight equidistant meridional arches. They remain single in *Discalia* (fig. 4), whilst they are forked and branched dichotomously in *Disconalia* (fig. 10).

Gonostyles.—The polypites (or secondary manubria) which produce by budding the medusiform gonophores are in the Discalidæ mouthless palpons, and not siphons provided with a mouth, as is the case in the nearly allied Porpitidæ and the more divergent Velellidæ; but also in the latter two families the gonostyles arise from the subumbrella in the same mouthless form, and acquire their mouth opening later. Their structure is the same as in the palpons of the Discalidæ. These are spindle-shaped or pyriform, much smaller than the central siphon; they form a regular simple corona around the base of the latter. *Discalia* (Pl. XLIX. figs. 1, 3) possesses eight, and *Disconalia*

(Pl. L. figs. 1, 2) sixteen gonostyles. The medusiform gonophores arise from their proximal part either isolated or in clusters (compare p. 37 above).

Tentacles.—The corona of submarginal tentacles exhibits in the Discalidæ very interesting forms, since these organs correspond in the two genera of this family to those of two important larval stages of the Porpitidæ. *Discalia* (Pl. XLIX. figs. 1, 4) possesses only eight simple radial tentacles of cylindrical form, which bear no lateral branches, but a simple terminal cnidosphere (or a spherical knob composed of radially disposed cnidocysts). The larva of the other genus, *Disconalia*, also exhibits in its young state eight simple tentacles (Pl. L. fig. 9), and hereafter at their distal end a group of four terminal cnidospheres (fig. 10). These become multiplied in older larvæ, and form a subumbrellar corona inside the limb of the umbrella. The adult *Disconalia* (Pl. L. fig. 1) possesses two rows of tentacles, in which eight perradial bunches are prominent. Each tentacle is cylindrical, with club-shaped distal end, and bears in its distal half three longitudinal rows of pediculate cnidospheres, an odd inferior and two paired lateral series (compare p. 38).

Ontogeny.—The individual development of the Discalidæ is not known, but is probably identical with that of the Porpitidæ (compare p. 39).

Phylogeny.—The phylogenetic value of the Discalidæ is, in my opinion, very great. I regard *Discalia* as a survival of the common ancestral form of all Disconectæ, and *Disconalia* as an intermediate form between this and *Porpalia*.

Synopsis of the Genera of Discalidæ.

Umbrella with eight simple tentacles. Pneumatocyst without concentric ring-chambers, .	1. *Discalia.*
Umbrella with numerous tentacles, arranged in eight radial bunches. Pneumatocyst with concentric ring-chambers, surrounding the octoradial central disc, . . .	2. *Disconalia.*

Genus 1. *Discalia*,[1] Haeckel, 1888.

Discalia, Hkl., System der Siphonophoren, p. 29.

Definition.—Discalidæ, with a lenticular or subglobular umbrella, including a lenticular pneumatocyst, which is composed of a central chamber and eight surrounding radial chambers, without concentric ring-chambers. Marginal tentacles eight, simple, with a terminal cnidal knob.

The genus *Discalia* is the simplest and most primitive form of all Disconectæ, and may be regarded as one of the common ancestral forms of this order. It may be compared to an octonemal Trachomedusa (*Trachynema*, *Marmanema*, *Rhopalonema*), which has developed an octoradial pneumatophore in its exumbrella, and in which the eight simple genital sacs of the subumbrella have been replaced by eight palpons or mouthless gonostyles, which afterwards produce medusiform gonophores by budding.

[1] *Discalia* = marine disc, δίσκος, ἅλιος.

All Porpitidæ probably pass during their metamorphosis through a larval stage, which is essentially identical with *Discalia*, and differs from it only in the absence of sexual palpons or gonostyles, bearing gonophores. The young larva of *Porpita linnæana*, which Alexander Agassiz has figured,[1] exhibits a larval stage which is a little more advanced, and forms the transition to the Disconalia-stage.

The phylogenetic importance of *Discalia*, therefore, is very great. On the one hand, it seems to indicate clearly the origin of the Disconectæ from the Trachomedusæ (Trachynemidæ); on the other hand, all the other Disconectæ may be derived from it as from a common ancestral genus.

Two species of *Discalia*, both inhabitants of the deep sea, were found by me in the Challenger collection. The first species, *Discalia medusina*, was taken in the centre of the Southern Pacific, at Station 288 (depth, 2600 fathoms), and is figured in Pl. XLIX. figs. 1–6. The second species, *Discalia primordialis*, was captured in the tropical Pacific, at Station 274 (depth, 2750 fathoms). The latter is distinguished from the former by a more flattened umbrella, and by eight longer (perradial) tentacles, between which eight shorter (interradial) were interpolated; but as its state of preservation was not sufficient, I give here only the description of the first well-preserved species.

Discalia medusina, n. sp. (Pl. XLIX. figs. 1–6).

Habitat.—Southern Pacific, Station 288, October 21, 1875; lat. 40° 3′ S., long. 132° 58′ W.; depth, 2600 fathoms.

Umbrella (fig. 1, view from below; fig. 2, from above; fig. 3, in profile; fig. 4, in meridional section).—The umbrella, which represents the nectosome, is subspherical, 0·2 to 0·4 mm. in diameter. A deep annular constriction separates the flatter exumbrella from the inflated and highly vaulted subumbrella. The latter bears in its equatorial zone a corona of eight simple tentacles, and beyond it a corona of eight gonostyles, which surround the central siphon.

Exumbrella (fig. 2).—The superior or apical face of the umbrella is rather flat, and exhibits an octoradial star of brown pigment, indicating the course of the eight perradial exumbrellar canals, or the superior vessels of the mantle. The apical stigma, or the superior opening of the central air-chamber, is situated in the centre of the pigment-star, whilst eight other stigmata, the outer openings of the eight interradial air-chambers, are placed between the eight rays of the dark pigment-star.

Limbus Umbrellæ (*uu*).—The circular margin of the umbrella is thickened and divided by eight perradial incisions into eight prominent flat interradial lobes. The whole margin is beset with a corona of the usual marginal glands (fig. 6) (compare p. 42 above).

[1] 57, pl. ix. figs. 1, 2.

Subumbrella (fig. 1).—The inferior or basal face of the umbrella is nearly hemispherical. Its centre is occupied by the central siphon (*sa*), and this is surrounded by a corona of eight gonostyles (*gs*). The equatorial zone of the subumbrella is beset with eight perradial tentacles, and between these proceed outside the eight interradial lobes of the limbus.

Pneumatocyst (fig. 2, *pf*, from above; figs. 4, 5 in meridional section).—The central air-chamber (*ph*) is spheroidal, large, and occupies about half the volume of the float. A prominent tubular stigma (figs. 4, 5, *po*) opens in the centre of its upper face. The eight radial air-chambers, which surround the former as a regular corona (*pq*), are crescentric, concave on the axial side, convex on the abaxial side; each opens by a stigma on the upper face (*pe*). The pneumatocyst possesses only eight simple tracheæ (*pt*), one arising from the inferior face of each radial chamber; the eight trachcæ descend obliquely and contorted downwards, enter into the centradenia (fig. 4, *uc*), and terminate in it; but they do not pass into the exodermal wall of the central siphon.

Centradenia (fig. 4, *uc*).—The large central gland is a circular disc, the diameter of which is about three to four times as great as its height, and equals that of the pneumatocyst. The inferior face of the latter is in close contact with the superior face of the former; whilst the inferior face of the centradenia is separated by a thick support, the gastrobasal plate, from the base of the central siphon. The whole mass of the solid centradenia is composed of exoderm cells. Its entodermal system of hepatic vessels is confined to an eight-rayed star on its superior face. The eight radial canals, which are connected in the centre of the latter, arise from the proximal third of the eight subumbrellar radial canals which run from the base of the central siphon towards the margin of the umbrella. This simplest form of the gastro-hepatic canal-system gives the explanation of its more complex form in the other Disconectæ.

Central Siphon (figs. 1–4, *sa*).—The central polypite is a thick-walled contractile tube, inversely conical in the proximal half, cylindrical in the distal half. Its length about equals the equatorial diameter of the umbrella, and is twice as great as the diameter of its base. The thick muscular wall is composed of a strong outer layer of exodermal longitudinal fibres, and a thin inner layer of entodermal circular fibres, both separated by a structureless elastic fulcrum. The distal mouth is octolobate.

The gastrobasis, or the horizontal roof of the stomach, is regularly octagonal, separated by a thick fulcrum, the gastrobasal plate, from the centradenia above it. It is pierced in the periphery by the gastral openings of the eight radial main vessels. These give off branches for the gonostyles and tentacles, and run centrifugally in the subumbrella towards the limbus, where they are united by a marginal ring-canal.

Gonostyles (figs. 1–4, *gs*).—The eight sexual palpons are about half as long and broad as the central siphon. They bear clusters of gonophores in their cylindrical basal part, patches of cnidocysts in their spindle-shaped distal part.

Tentacles (figs. 1–4, *t*).—The eight tentacles are cylindrical, somewhat larger than the diameter of the umbrella, and bear a single cnidosphere at the distal end.

Genus 2. *Disconalia*,[1] Haeckel, 1888.

Disconalia, Hkl., System der Siphonophoren, p. 30.

Definition.—Discalidæ, with a lenticular or discoidal umbrella, including a discoidal pneumatocyst, which is composed of a central chamber, eight surrounding radial chambers, and several concentric ring-chambers. Marginal tentacles numerous, arranged in eight radial bunches.

The genus *Disconalia* is closely allied to the preceding ancestral genus *Discalia;* but it differs from it in the multiplication of the marginal tentacles, which form eight marginal bunches; and mainly in the peripheral increase of the octoradial pneumatocyst, which is surrounded by several concentric ring-chambers. It corresponds therefore to that larval stage of the Porpitidæ which Alexander Agassiz[2] has figured of *Porpita linnæna*. The young larvæ, probably of all species of Porpitidæ, after having passed the Discalia-form, assume a transitional Disconalia-form.

Perhaps even Eschscholtz observed a Disconecta belonging to this genus. The interesting small form, taken in the tropical Pacific, which he figures under the name *Porpita ramifera*,[3] is either a true *Disconalia*, or the corresponding larva of some Porpitid passing through this typical stage. The answering of this question is not possible, since the organs of the subumbrella, which would be decisive, are neither figured nor even mentioned in the description given by Eschscholtz.

Two species of *Disconalia* (both deep-sea inhabitants) were found by me in the Challenger collection, one from the Southern Pacific (Station 181), the other from the Indian Ocean, south of Australia (Station 157). The latter (*Disconalia pectyllis*) had much longer and less ramified tentacles, and a larger pneumatocyst, than the former (*Disconalia gastroblasta*); but its state of preservation was not sufficient for a full description. Regarded from a phylogenetic point of view, *Disconalia* is of the highest importance as a necessary connecting link between *Discalia* and *Porpalia*. It is derived from the ancestral genus *Discalia* by the multiplication of the air-chambers and the tentacles; if its gonostyles acquired a mouth, it would pass into *Porpalia*.

Disconalia gastroblasta, n. sp. (Pl. XLIX. figs. 7–12; Pl. L. figs. 1–10).

Habitat.—Southern Pacific, north-east of Australia, Station 181, August 25, 1874; lat. 13° 50′ S., long. 151° 49′ E.; depth, 2440 fathoms.

[1] *Disconalia*, derivative from *Discalia*. [2] **57**, pl. ix. fig. 3. [3] **1**, p. 17, Taf. 16, figs. 3*a*, 3*b*.

Umbrella (Pl. L. fig. 1, from below).—The umbrella is slightly vaulted, lenticular, nearly discoidal, 4 to 6 mm. in diameter; its vertical axis is about 1 mm. The margin is regularly octolobate, with eight deep marginal incisions, from which arise the eight bunches of tentacles.

Exumbrella (Pl. XLIX. fig. 7).—The superior face of the umbrella is rather flat, a little vaulted, and exhibits a regular network of brown pigmented canals, the exumbrellar vessels. Eight regular radial canals arise from a central circular canal, in the centre of which is placed the apical stigma of the pneumatocyst. The eight interradial chambers of the latter are separated by these perradial mantle canals, which anastomose outside and form a ring around each chamber. From this ring arise in each octant four to six centrifugal canals, which are forked and prolonged outside the pneumatosaccus into the exumbrellar canals of the limbus. Their dichotomous branches are connected by anastomoses. A few peripheral stigmata are scattered in the outer half of the exumbrella.

Limbus Umbrellæ (fig. 7, *um*).—The free margin of the umbrella, outside the corona of tentacles, is distinctly octolobate, and bears a series of pyriform marginal glands on its free edge. The eight interradial convex lobes are more or less prominent between the eight perradial bunches of tentacles.

Subumbrella (Pl. XLIX. fig. 11).—The inferior face of the discoidal umbrella is more convex than the superior, and is divided into four different zones. The central zone is occupied by the large central siphon (*sa*). This is surrounded by a corona of sixteen gonostyles, and this by an octagonal tentacular zone (fig. 12, *tu*). Outside the latter is prominent the broad octolobate limb of the subumbrella.

Pneumatocyst (fig. 8, half of the inferior face; fig. 9, half of the superior face).—The subspherical central chamber (*ph*) possesses an apical stigma in the centre of its upper face, and is surrounded by a corona of eight equal triangular radial chambers, each of which bears a circular stigma. This octoradial central disc is surrounded by a peripheral girdle composed of eight or nine concentric ring-chambers; the second and third of these (*pk*) are the broadest, much broader than the peripheral chambers. Eight deep perradial furrows of the lower face separate the eight chambers of the octoradial ring one from another, and are prolonged up to the circular margin of the pneumatocyst, dividing it into eight slightly prominent lobes. In the middle between each two furrows (therefore in eight interradial rows) may be seen the pneumathyræ, or openings by which the concentric ring-chambers communicate one with another (fig. 8, *pg*).

The superior or apical face of the discoidal pneumatocyst (fig. 9) is slightly convex, and bears about twenty stigmata, viz., one central, eight interradial (in the middle of the eight triangular chambers), and eight to twelve peripheral, irregularly placed in the second to the fourth ring-chamber.

The inferior or basal face of the pneumatocyst (fig. 8) is slightly concave, and bears

between fifty and ninety short tracheæ (six to twelve in each octant). These are placed in the periphery of the octoradial ring, and in the two to four next following chambers; they are wanting in the periphery.

Centradenia (figs. 10–12, *uc*).—The large central gland, or so-called "liver," is an octagonal, lenticular, biconvex disc, of the same horizontal diameter as the overlaying pneumatocyst. Its thickness is inconsiderable, and decreases towards the periphery. Its convex superior face (fig. 10) is in close contact with the concave inferior face of the latter. The peripheral octagonal margin of the centradenia does not exceed that of the covering pneumatocyst.

The inferior face of the centradenia is rather flat, and is separated by a thin fulcrum from the subumbrella. Its central part is in contact with the gastrobasal plate of the central siphon; its peripheral part with the corona of gonostyles, and its margin with the corona of tentacles.

The structure of the centradenia exhibits in *Disconalia* the same remarkable simplicity and typical form as in *Discalia*. The solid parenchyma is entirely composed of masses of aggregated exoderm-cells, with innumerable cnidocysts. A regular octoradial star of pigmented hepatic vessels is placed on its superior face (fig. 10). From the centre of the latter arise eight perradial brown "liver-canals," which branch dichotomously, and run on its upper face towards its peripheral margin. They pass here over into the peripheral canal-network of the subumbrella, from which arise the canals of the tentacles and gonostyles.

Central Siphon (Pl. L. figs. 1, 3).—The large central polypite has the usual form of an inverted cone. The broad octagonal base occupies the central area of the subumbrella, and is separated from the centradenia above it by the gastrobasal plate. The periphery of the base opens by eight perradial ostia (Pl. XLIX. fig. 12) into the eight radial main vessels which run in the subumbrella towards the limb, and give off the ascending centripetal canals of the "liver-star" (fig. 10).

The muscular wall of the central siphon is very thick. It opens by a distal octolobate mouth, the edges of which are strongly armed with cnidocysts (Pl. L. fig. 3).

Gonostyles (Pl. L. figs. 1, 2).—Sixteen sexual palpons, or mouthless gonostyles, form a corona around the base of the sterile central siphon. They are small spindle-shaped sacs, scarcely half as long as the central siphon. Their wider basal half bears clusters of gonophores (fig. 2, *g*), whilst the slender distal half is beset with cnidonodes (*k*); the closed distal end is obtusely conical and entirely covered by cnidocysts.

Tentacles (Pl. L. figs. 1, 4–6).—The tentacles are very numerous and densely crowded in the subumbral groove between the corona of gonostyles and the limb of the umbrella. They alternate here in a double row (Pl. XLIX. figs. 1, 2). The tentacles which arise from the eight perradial corners of the octagonal girdle are much longer than the interjacent interradial, and form therefore eight prominent bunches.

The structure of the cylindrical tentacles is the same as in all Porpitidæ. They bear three rows of pediculate cnidospheres in their club-shaped distal half, one inferior and two opposite lateral rows (figs. 4–6).

Family II. PORPITIDÆ, Brandt, 1835.

Porpitidæ, Brandt, Prodromus, **25**, p. 40.

Definition.—Disconectæ with a circular permanent umbrella, including a campanulate or discoidal pneumatocyst, which is composed of an octoradial centre and numerous concentric rings, without vertical crest. No vertical sail upon the umbrella. Submarginal tentacles with three rows of pediculate cnidospheres. Central siphon surrounded by numerous peripheral fertile siphons, which bear the gonophores.

The family Porpitidæ, founded in 1835 by Brandt for the genus *Porpita*, comprises all those Disconectæ polygastricæ which have a circular umbrella and a regular originally octoradial ground-form. They agree in their regular octoradiate form with the monogastric Discalidæ, their ancestral group, but differ from them essentially in the polygastric structure which they share with the Velellidæ. Not only does the primary sterile central siphon possess a mouth opening at its distal end, but likewise also each of the surrounding gonostyles. These peripheral polypites, which bear the gonophores budding from their proximal part, are therefore not mouthless palpons (as in the Discalidæ), but mouth-bearing, feeding, and digesting secondary siphons. The Velellidæ, with the same polygastric organisation, differ from the Porpitidæ in the amphithect or bilaterally-radial type, and in the development of a vertical sail upon the exumbrella.

Eschscholtz, in his fundamental work,[1] described five different species of Porpitidæ, which he united in the single genus *Porpita*. Lesson[2] added to this two other genera (each with a single species), *Ratis* and *Acies*. His description, however, is very incomplete, and not illustrated by any figure, so that it is impossible to decide whether they are merely young forms of *Porpita* (as most authors suggest) or perhaps Discalidæ.

Some interesting new Porpitidæ, found in the Challenger collection, and some other new forms observed by myself on different occasions, have led me to divide this family into four genera (characterised in my System).[3] These may again be disposed in two subfamilies, the Porpalidæ and the Porpitellidæ, each with two genera. The first subfamily, Porpalidæ, has a lenticular or subglobular umbrella and a campanulate pneumatophore with lobate margin (*Porpalia* and *Porpema*); whilst the second subfamily, Porpitellidæ, possesses a flat discoidal umbrella and a medal-shaped pneumatophore with a circular, not lobate margin (*Porpitella* and *Porpita*).

Umbrella.—The complete body of all Porpitidæ is circular, sometimes more lenticular

[1] 1, 1829, p. 176. [2] 3, 1843, p. 592. [3] 95, 1888, p. 30.

or subglobular (in the Porpalidæ), sometimes more flatly expanded or discoidal (in the Porpitellidæ). Its vertical main axis is in the first case little shorter or nearly as long as the horizontal or equatorial axis; whereas in the second case it is much shorter, only one-half or one-third as long, or even less. The free prominent margin, or the glandiferous *limbus umbrellæ*, marks the boundary between the exumbrella (upper or pneumatophorous half) and the subumbrella (lower or siphonophorous half).

Exumbrella.—The upper, apical or proximal, part of the discoidal trunk, which corresponds to the exumbrella of the Medusæ, and physiologically represents the nectosome, is in all Porpitidæ circular and composed of the pneumatocyst, filled with gas, and the surrounding pneumatophore. This latter is composed of two parallel membranes, separated by a network of anastomosing radial canals—the outer thicker membrane armed with thread-cells and pierced by the stigmata, is the pneumatocodon; the inner thinner membrane, immediately including the pneumatocyst, is the pneumatosaccus or the invaginated exoderm. Both membranes are connected by numerous branched radial septa, and the cavities between these, radiating from the centre of the disc, are the radial canals of the exumbrella (pallial vessels); they open at the margin of the disc into the large circular canal of the limb.

The surface of the exumbrella is in many Porpitidæ smooth, in others more or less papillate, owing to conical protuberances of the pneumatocyst. Often an elegant multiradiate pigment-star is visible, produced by a dark pigment in the wall of the pallial vessels. The central part of the exumbrella in all Porpitidæ is pierced by a central stigma, and a surrounding corona of eight stigmata placed in the walls of the eight surrounding radial chambers. The other stigmata of the exumbrella, in larger species several hundreds, in smaller only few, are sometimes disposed in regular radial rows, at other times more irregularly scattered.

Pneumatocyst.—The chitinous polythalamous float filled with gas, which is called pneumatocyst (formerly "inner shell"), is in the Porpitidæ always regularly circular, corresponding to the surrounding pneumatosaccus (or the invaginated exumbrella) from which it is secreted. Consequently its general form in the subfamily Porpalidæ is highly vaulted, campanulate or cap-shaped (*Porpalia, Porpema,* Pls. XLVII., XLVIII.), whereas in the flatly expanded Porpitellidæ it is discoidal, even or slightly vaulted (*Porpitella* and *Porpita,* Pls. XLV. and XLVI.). The pneumatocyst is always composed of two little distant and nearly parallel lamellæ of structureless chitin, which are connected by numerous concentric annular septa. The latter divide the float into numerous concentric ring-chambers, and these open on the upper or proximal face by stigmata, on the lower or distal face by tracheæ.

The *central disc of the pneumatocyst* has in the Porpitidæ the same structure as in the Discalidæ; it is composed of a spherical or subglobular central chamber (with a central stigma above) and of eight equal triangular radial chambers, each of which bears

a stigma above, and a trachea (or a bunch of tracheæ) below. This evident octoradial structure of the central part is often lost in the peripheral part of the pneumatocyst.

The *concentric ring-chambers* which compose the latter are simple circular rings, without radial septa. Their number is very variable, in the smaller species ten to twelve, or even less, in the larger species forty to sixty, and in the largest more than a hundred. They are usually of nearly equal breadth; often, however, the chambers of the middle part are wider than the more proximal (near the centre) and the more distal chambers (near the margin). The first or innermost of the concentric ring-chambers is different from all others; it embraces the octoradial central disc not only from the outer (abaxial) but also from the lower (basal) side (Pl. XLVI. figs. 3, 6).

Pneumothyræ.—It is a general opinion that the concentric circular ring-chambers of the Porpitidæ are perfectly separated one from another by solid annular septa. But this is not the case. I found in all members of this family openings of communication between them, which I shortly call pneumothyræ. The thin chitinous annular septa, which separate the ring-chambers, are concave on the axial side, convex on the abaxial side, they are usually thicker in the upper, thinner in the lower, part. Each annular septum is pierced in its basal part by at least eight pneumothyræ, ovate or roundish openings, which are about twice as broad as the stigmata of the upper surface. The pneumothyræ or ring-gates (Pl. XLVI. figs. 3, 4, *pg*) lie originally in the same radii as the stigmata (*pe*). There are, therefore, eight interradial rows of pneumothyræ. But in the larger species their number is increased, accessory pneumothyræ being interpolated between the primary ones in the outer chambers.

The superior, proximal or apical side of the pneumatocyst is usually flat in the central part, whilst the peripheral part is highly convex or campanulate in the Porpalidæ, slightly convex or even in the Porpitellidæ. Its surface is sometimes smooth, at other times rough and marked by radial stripes or ribs, and by concentric circles. It is sometimes, mainly in the central part, spiny, papillate, or armed with conical, irregularly scattered tubercles. The chitinous substance in the central part is often much thickened by apposition of secondary layers, and these may close the stigmata of that part. Those of the peripheral part remain always open.

The *stigmata*, or the pneumatic foramina on the upper face of the pneumatocyst (*pe*), are much more numerous in the Porpitidæ than in the Discalidæ and Velellidæ. Constantly there is a central stigma in the apex of the central chamber, and around this a regular corona of eight equidistant stigmata in the eight radial chambers which surround the former. The other stigmata are usually not regularly disposed, but scattered in great numbers over the upper surface. When the latter is provided with radial ribs or prominent ridges, the stigmata are placed in the height of the ridges, not in the valleys between them. The stigmata are sometimes simple openings in the upper wall of the

ring-chambers. But usually they are dilated in the middle, more or less urn-shaped, and sometimes prolonged into short prominent tubules (Pl. XLVIII. fig. 8, *pe*).

The inferior, distal or basal side of the pneumatocyst, separated by the exodermal epithelium of the pneumatosaccus from the neighbouring superior face of the centradenia, corresponds in its general form to the latter, and has therefore a more complicated shape than its superior face. It is always more or less concave, hemispherical or campanulate in the Porpalidæ, slightly concave or cap-shaped in the Porpitellidæ. Numerous radial ridges or folds are prominent from the inferior face of the float, and often these arise in the form of vertical radial lamellæ, separated by deep valleys. These latter are filled up by corresponding high radial ridges of the upper face of the centradenia. The number of the radial ridges increases rapidly towards the periphery, numerous secondary and tertiary centripetal lamellæ (which do not reach the centre) being interpolated between the centrifugal primary ones. The concave under surface of the pneumatocyst, and the convex upper surface of the centradenia, catching one into another, become very similar to a *Fungia* (Pl. XLVIII. fig. 7). From the combs of the prominent radial ridges arise the tracheæ (fig. 6, *pt*).

Tracheæ.—The pneumatic tubules or aëriferous filaments, which we call shortly tracheæ, are much more numerous in the Porpitidæ than in the Discalidæ and Velellidæ. Each radial ridge bears in the larger species on an average more than one hundred tracheæ, and as the number of the ridges there amounts to some hundreds, the number of the tracheæ reaches many thousands. The innermost tracheæ, nearest the main axis, arise from the eight radial chambers which surround the central chamber. The other tracheæ arise sometimes isolated, in irregular radial series, from the crest of the ridges, at other times in bunches, crowded in small groups of three to six or nine, rarely more.

The aëriferous tubules are usually simple, very rarely branch, and never anastomose. Their thin chitinous wall is cylindrical, of very different length. Their course is never straight, always more or less curved, and often serpentine. The tracheæ of all Porpitidæ are distinctly articulate, and seem to be composed of a series of short truncate conical segments; the distal or inferior end of each segment is wider (Pl. XLVI. fig. 8). Sometimes each segment seems to be separated from the other by a transverse septum; but the apparent septum is merely an annular constriction. The two ends of each ring-segment (proximal and distal) remain always open.

The *course of the tracheæ* is difficult to make out. Descending from the lower face of the pneumatocyst, they enter immediately into the centradenia, and run in sinuous curves between the canal-network of this organ. A great part finishes inside the central gland, whilst another part descends deeper and passes into the wall of the central siphon and the peripheral siphons. They end here in the exoderm of the proximal half of the siphons, and do not enter into their distal half. Usually the great majority of the tracheæ are much shorter than the vertical diameter of the centradenia; they must there-

fore finish in the solid glandular parenchyma of this latter, and cannot pass through it and enter into the wall of the siphons. A small part only of the tracheæ enters into this latter. The distal ends of all tracheæ are open, surrounded by exodermal epithelia, as in the other Disconectæ. No tracheæ are found in the marginal tentacles, nor in the peripheral part of the umbrella outside the centradenia.

The margin of the pneumatocyst is circular and not lobate in the flat discoidal Porpitellidæ, whilst it is divided into numerous radial lobes in the campanulate Porpalidæ; the lobes are here sometimes small, sometimes widely prominent. Their number is originally eight or sixteen, and by furcation thirty-two or sixty-four (Pl. XLVIII. figs. 4, 5).

Central Siphon.—The large central polypite of the Porpitidæ is not different from that of the Discalidæ, a thick-walled and very contractile tube of very variable form. Usually it is inversely conical, its diameter decreasing gradually from the broad proximal base towards the distal mouth. Sometimes the upper half, or the stomach, is ovate and much wider than the lower half, or the cylindrical proboscis. Its transverse section is either circular or octagonal, in consequence of eight prominent radial folds. In some larger species the outer wall exhibits sixteen longitudinal folds instead of eight, and sometimes eight larger (perradial) and eight smaller (interradial) ribs alternate. To these correspond the same number of internal furrows at the inside of the siphon. These furrows lead into the basal openings of the stomach, in which the primary radial canals open (eight or sixteen). The basal ostia form a regular corona; in some larger species their number is increased, numerous secondary and tertiary ostia being intercalated between the eight primary ones. The base of the stomach is separated completely from the overlaying centradenia by the structureless solid gastrobasal plate.

Centradenia.—The large central gland, or the so-called "central organ" (formerly "liver"), exhibits the peculiar composition described above (p. 31). In the Porpitidæ it is much more voluminous than in the Discalidæ and Velellidæ, and occupies the whole space between the inferior face of the pneumatophore and the superior face of the subumbrella which bears the siphons. The central gland is largest in some lenticular or subglobular Porpalidæ, where its weight and volume are greater than those of all other parts of the body together; it is relatively smaller in the flat discoidal Porpitellidæ. The dense network of canals in the central gland is in its upper brown or blackish half composed of hepatic vessels (with biliary epithelium), in its lower green or whitish half of renal vessels (with epithelium secreting guanin crystals). The compact exodermal epithelium filling up the intervals of the canal-network contains masses of cnidoblasts and probably secretes the gas, which enters into the open distal ends of the tracheæ.

Gonostyles.—The numerous polypites of the subumbrella, which produce by budding the medusiform gonophores, in the Porpitidæ are not mouthless palpons as in the Discalidæ, but mouth-bearing siphons as in the Velellidæ. They are, therefore, usually called "smaller polyps, sexual polypites, or peripheral siphons" (shortly "perisiphons"). They

either form a simple ring of eight or sixteen gonostyles around the central siphon, or they occupy a broader gonostylar zone, often the whole subumbrella between the central siphon and the submarginal corona of tentacles. At first there is a corona of eight gonostyles only, regularly placed around the central siphon, and this state is permanent in some species of *Porpalia* (Pl. XLVIII.). In *Porpitella* (Pl. XLVI.) there is a girdle of sixteen gonostyles. But usually their number is soon increased, and they form several concentric circles, more or less regular. Finally, in the largest Porpitidæ their number amounts to several hundreds, and they are densely crowded. Their form and structure have been described above (p. 36).

Tentacles.—The corona of submarginal tentacles in all Porpitidæ is originally regularly octoradial. In all young larvæ of this family there occurs a stage in which the umbrella-margin bears only eight tentacles regularly disposed at equal intervals (Pl. L. figs. 9, 10), as permanently in *Discalia* (Pl. XLIX. figs. 1–4). But their number is soon increased either by interpolation of eight secondary interradial tentacles (in the middle between the former), or by budding of several secondary tentacles at the base of each primary one, so that eight regular bunches arise (*Porpalia*, Pl. XLVIII.). Sometimes sixteen bunches are formed (*Porpitella*, Pl. XLVI.). Usually the number is so increased that hundreds or thousands of tentacles, densely crowded, cover the whole zone beyond the margin of the disc. Often three to nine or more concentric circles may be discerned, and then the uppermost are the smallest, the lowermost the longest. Sometimes their bases are so densely crowded in the tentacular area, that after removing the tentacles there appears an elegant reticulated girdle beyond the margin; each rhomboidal dimple of the reticulum is the place of the basal insertion of a lost tentacle (Pl. XLVII. fig. 3, *tu*; Pl. XLVIII. fig. 2, *tu*).

The *general structure of the tentacles* is the same in the Porpitidæ as in the other Disconectæ; but they differ from those of the Velellidæ in their peculiar constant form and structure. The youngest larvæ of the Porpitidæ bear eight simple radial tentacles with a terminal cnidosphere (Pl. L. fig. 9) like those of *Discalia*. The next larval stage exhibits four pediculate cnidospheres at the distal end of each tentacle, one of which is the primary terminal knob, the three others basal branches of it (fig. 10). The number of the latter is soon multiplied, and the older and longer tentacles, which are club-shaped and thickened at the rounded distal end, bear always three longitudinal rows of pedunculated cnidospheres; one odd inferior series in the middle line of the lower or distal face, and two paired (lateral) series on the two lateral faces; the upper or proximal face is always smooth.[1] Each cnidosphere is a thin lateral branch of the tentacle, having the same structure as the latter, and bearing a terminal sphere composed of radially crowded cnidoblasts. The peduncles of the latter are sometimes shorter, at other times longer. Their length often increases towards the distal end of the tentacle. Their number is very variable in different

[1] 57, pls. ix., x.

species; usually each of the three longitudinal rows bears six to nine branches, often twelve to twenty or more (Pl. L. figs. 1–6).

Ontogeny.—The individual development of the Porpitidæ has hitherto been unknown. I conclude, however, from the comparative morphology of the new Porpitidæ and Discalidæ here described, that all members of these two families pass through a larval stage very similar to *Discalia*. This is subject to a shorter or longer metamorphosis, and passes through a stage similar to *Disconalia*. The transition from this to *Porpalia*, the simplest form of Porpitidæ, is easy to conceive. The gonostyles acquire a mouth, and so the sexual palpons of the former are replaced by the sexual siphons of the latter.

The medusiform gonophores, which are produced from these gonostyles by budding, have the same form and structure as the well-known *Discomitra* (afterwards *Chrysomitra*) larvæ of the Velellidæ.[1] They become sexually mature in the free medusoid state, after having been detached from the gonophores. The larvæ which arise from the fertilised egg have not yet been observed.

Phylogeny.—The comparative morphology of the Porpitidæ and Discalidæ admits the phylogenetic hypothesis that the former have arisen from the latter. When *Disconalia* acquires a terminal mouth on the distal end of each blastostyle, it passes over into *Porpalia*.

Synopsis of the Genera of Porpitidæ.

I. Subfamily PORPALIDÆ. Umbrella highly vaulted. Pneumatocyst campanulate, with a radially lobate margin.	Tentacles arranged in eight radial bunches, the eight primary more prominent, ...	3. *Porpalia.*
	Tentacles very numerous, in a circular corona, the eight primary not prominent, ...	4. *Porpema.*
II. Subfamily PORPITELLIDÆ. Umbrella flat, slightly vaulted. Pneumatocyst discoidal, without prominent radial marginal lobes.	Tentacles arranged in sixteen radial bunches, the eight primary and the eight secondary prominent, . .	5. *Porpitella.*
	Tentacles very numerous, in a circular corona, the eight primary not prominent, ...	6. *Porpita.*

Subfamily 1. PORPALIDÆ, Haeckel.

Genus 3. *Porpalia*,[2] Haeckel, 1888.

Porpalia, Hkl., System der Siphonophoren, p. 30.

Definition.—Porpitidæ with a lenticular or subglobular strongly vaulted umbrella, including a campanulate pneumatocyst with radial marginal lobes. Tentacles numerous, arranged into eight or sixteen prominent radial bunches.

[1] 57, pl. x.

[2] *Porpalia*=Marine ring of a buckle, πόρπη, ἅλια.

The genus *Porpalia* and the following *Porpema* together make up the subfamily Porpalidæ, characterised by a strongly vaulted, lenticular or nearly spherical, umbrella, which includes a mitriform or campanulate pneumatocyst; the distal margin of the latter being divided into radial lobes. The chitinous substance of this lobate pneumatocyst in the Porpalidæ is much thinner, more delicate, and softer than in the Porpitellidæ (*Porpitella* and *Porpita*), sometimes it resembles crumpled tissue-paper. The numerous marginal tentacles in *Porpalia* are arranged in eight regularly disposed radial bunches, whilst in *Porpema* they are equally distributed along the margin of the umbrella.

The genus *Porpalia* is founded upon a new species, *Porpalia prunella* (Pl. XLVIII.), well-preserved specimens of which were found in the Challenger collection, taken in the tropical Pacific (Station 222). The incomplete description of another species of this genus, founded upon a single specimen, was given in 1829 by Eschscholtz, under the name *Porpita globosa*.[1] He took this specimen in the tropical Atlantic, near the Cape Verde Islands. The exumbrella is in this Atlantic *Porpalia globosa* much smaller, but the tentacles larger than in our species from the Pacific.

The phylogenetic position of *Porpalia* is clearly indicated by its morphological relation to *Disconalia* on one hand, and to the *Porpula* larvæ of the other Porpitidæ on the other. It may be regarded as the common ancestral form of this family derived from *Disconalia* by the formation of a mouth on the distal ends of the gonostyles.

Porpalia prunella, n. sp. (Pl. XLVIII.).

Habitat.—Tropical Pacific, north of New Guinea, Station 222; March 6, 1875; lat. 12° 15′ N., long. 146° 16′ E. Surface.

Umbrella (fig. 1, as seen from above; fig. 2, in profile; fig. 3, in meridional section).—The umbrella is biconvex lenticular; its diameter amounts to 4 or 5 mm. (without tentacles and siphon). A deep submarginal ring-furrow separates the flat exumbrella from the biconvex body, the superior face of which is more strongly vaulted than the inferior. The equatorial diameter of the biconvex lens is twice as great as its vertical main axis.

Exumbrella (figs. 1–3, *ue*).—The superior or apical face of the umbrella is rather flat, with a shallow ring-furrow separating the central disc from the elevated peripheral margin. The central disc exhibits an elegant pigment-star with eight dark brown rays. Numerous stigmata are disposed in irregular rows between them.

Limbus Umbrellæ (figs. 1–3, *um*).—The free prominent border or limb of the umbrella is as broad as the radius of the central disc of the umbrella, and therefore half as broad as the equatorial radius of the lens. Its upper face is concave, the lower convex. The thickened margin is reflected upwards, and contains a single series of the usual muciparous glands (compare above).

[1] 1, p. 178, Taf. 16, fig. 4.

Subumbrella (figs. 1–3, *w*).—The inferior or basal face of the umbrella exhibits beyond the deep submarginal ring-furrow a broad naked girdle, in which the radial canals ascend from the tentacular zone to the margin of the umbrella. The tentacular zone begins in the equator of the biconvex lens, and occupies the peripheral half of its lower convexity. Its breadth equals the radius of the central disc of the exumbrella.

Pneumatocyst (fig. 4, from above; fig. 5, from below; fig. 3, *p*, in vertical meridional section).—The float, filled with air, is campanulate, and envelops the subspherical centradenia, with exception of its basal centre, which is occupied by the central siphon. The equatorial diameter of the pneumatophorous bell is twice as great as its vertical main axis. The basal opening of the bell, closed by the base of the central siphon, is scarcely greater than half its height. The concave inferior face (or the cavity of the bell) is in close contact with the centradenia, and the thirty-two prominent radial crests of the former fit into thirty-two deep radial furrows of the latter. The convex superior face is flatly conical above the equator (*ug*); its peripheral girdle, beyond the equator, is regularly divided into sixteen furcate radial lobes (or thirty-two smaller lobes).

The central chamber of the pneumatocyst is surrounded by a regular girdle of eight radial chambers, each of which possesses a stigma on its upper, and a trachea on its lower side. This octoradial girdle is surrounded by eight to ten complete, concentric, circular ring-chambers, the outermost of which touches the equator of the lens. Outside follows the peripheral girdle of thirty-two lobes, which is recurved inwards and downwards (horizontally expanded by pressure, see fig. 4). The superior or convex face of the pneumatocyst bears in its superior central part (which is in contact with the exumbrella) numerous radial rows of stigmata. From its inferior or concave face, which is in contact with the centradenia, hang down thirty-two prominent radial crests, or rather lamellar pouches (fig. 6); and from the lowermost part of the latter arise numerous long tracheæ which enter into the glandular tissue of the liver (fig. 3, *uc*); the majority of them terminate here with open distal ends, whilst a small part of the tracheæ enters into the basal part of the wall of the siphons, and ends in its exodermal epithelium.

The chitinous substance of the thin wall of the campanulate pneumatocyst is very delicate and richly folded, like crumpled tissue-paper.

Centradenia (fig. 3, *uc*).—The large central gland is nearly spherical, and entirely fills up the subumbrellar cavity of the pneumatocyst. The circular polar area only of its lower pole is in contact with the base of the central siphon. Besides this smooth inferior area, the entire surface of the centradenia is traversed by numerous deep meridional grooves, which are filled by the lamellar radial pouches of the basal face of the pneumatocyst. The dense parenchyma of its exodermal cellular tissue is traversed by numerous bent tracheæ, and by a loose network of hepatic canals. The latter arise from a regular octoradial star of superior liver-canals, which unite in the superior or apical pole of the centradenia. These eight radial main canals embrace the greater part of its surface like

eight meridional arches, and open on the periphery of its inferior polar area into the gastral cavity of the central siphon. Their dichotomous branches run along the convex outer surface of the centradenia, enclosed in the numerous radial folds which fit into the corresponding meridional furrows of the subumbrellar face of the pneumatocyst.

Central Siphon (fig. 2, in profile; fig. 3, in longitudinal section).—The large central polypite is a thick-walled cylindrical tube, the length of which surpasses the vertical main axis of the umbrella. Its distal end opens by a four-lobed mouth, whilst its proximal or basal part is conically dilated and closed by the supporting plate separating it from the centradenia (fig. 3). In the periphery of the latter open the eight radial main canals.

Sexual Siphons (figs. 2, 3, *sx*).—A corona of eight sexual polypites surrounds the base of the central siphon, and separates it from the tentacular zone. These are much smaller than the central siphon (about half as long, and many times thinner). Their thin cylindrical basal part is beset with numerous gonophores; their spindle-shaped distal part opens by a four-lobed mouth.

Tentacles (figs. 1–3, *t*).—The tentacles are very numerous, and occupy a broad convex zone of the subumbrella, between its equator and the girdle of sexual siphons. After removal of the tentacles, their insertion forms an elegant reticulate girdle, with rhomboidal meshes (fig. 2, *tu*). The tentacles are arranged in four to five transverse rows, and in eight prominent radial bunches; the longest of each bunch surpassing the diameter of the umbrella.

Genus 4. *Porpema*,[1] Haeckel, 1888.

Porpema, Hkl., System der Siphonophoren, p. 30.

Definition.—Porpitidæ with a lenticular or subglobular strongly vaulted umbrella, including a campanulate pneumatocyst with radial marginal lobes. Tentacles very numerous, equally disposed in several concentric circles, not forming radial bunches.

The genus *Porpema* has the same strongly vaulted umbrella and the same campanulate and radially lobate pneumatocyst as the preceding genus *Porpalia*, from which it differs in the equal distribution of the tentacles along the whole margin of the umbrella. The tentacles are very numerous and densely crowded in several parallel circles (as in *Porpita*), and they are not grouped into radial bunches.

The new genus *Porpema* was established for an Indian species, *Porpema lenticula*, which I observed in 1881 in the Indian Ocean, between Aden and Bombay. Another species, described in the following pages as *Porpema medusa* (Pl. XLVII.), was found in the Challenger collection; this was taken in the South Atlantic, Station 327 (between Buenos Ayres and Tristan da Cunha). A third species (*Porpema pileata*) was sent me from Chili; it will be described in my Morphology of the Siphonophoræ.

[1] *Porpema* = Mantle, cloth, πόρπημα.

Regarding the phylogenetic origin of *Porpema*, we may simply assume that it has been derived from the ancestral genus *Porpalia*, by multiplication and equalisation of the submarginal tentacles, which form circular girdles, without octoradial arrangement.

Porpema medusa, n. sp. (Pl. XLVII.).

Habitat.—South Atlantic, Station 327; March 4, 1876; lat. 36° 48′ S., long. 42° 45′ W. Surface.

Umbrella (fig. 1, from above; figs. 2 and 3, in profile, fig. 2 with tentacles, fig. 3 after removal of them; fig. 4, meridional section).—The umbrella is nearly spherical, and has a diameter of 4 to 6 mm. (without the tentacles and the siphon). In some specimens the vertical main axis is somewhat shorter than the equatorial diameter, in other specimens a little longer.

Exumbrella (figs. 1, 2, 3, *ue*).—The superior or apical face is slightly convex, cap-shaped, with a flat annular furrow which separates the central disc from the elevated margin, like a flat hat with a recurved brim. The central disc exhibits a dark pigment-star with sixteen broad rays, and a greater number of finer rays between the dark prominent main rays. A great number of stigmata is arranged in radial rows.

Limbus Umbrellæ (figs. 1–4, *uu*).—The free prominent border or margin of the umbrella is nearly horizontally expanded, and slightly reflected upwards, like the broad brim of a flat hat; it is concave above, convex below. The breadth of the margin equals the diameter of the exumbrellar central disc, and half the equatorial diameter of the subglobular umbrella. The thickened edge of the margin is beset with a series of the usual muciparous glands (compare above).

Subumbrella (figs. 1–4, *w*).—The inferior or basal face of the umbrella exhibits beyond the deep submarginal ring-furrow a narrow, smooth zone, which is radially striped; these stripes are the radial canals ascending from the corona of tentacles to the margin of the umbrella. The broad tentacular zone of the subumbrella (fig. 3) is a circular girdle, which embraces the equatorial zone of the whole umbrella; its vertical height equals the radius of the latter. After removal of the tentacles it appears elegantly panelled (fig. 3, *tu*).

Pneumatocyst (fig. 7, from above; fig. 8, from below; fig. 4, *p*, in vertical section).—The float, filled with air, is campanulate or nearly spherical, with a central opening at the basal pole of its vertical main axis. The diameter of this inferior opening measures 1 mm., and is about one-third as great as that of the float (3 mm.). The spherical outer surface of the pneumatocyst is in close contact above with the exumbrella, beyond the equator with the tentacular zone of the subumbrella. The inner cavity of the

campanulate double-walled float is filled up by the centradenia (*uc*), which passes through its basal aperture (fig. 4).

An exquisite regular octoradial structure is visible in all parts of the pneumatocyst. The central chamber (*ph*) is nearly cylindrical, with an apical stigma (*po*), and surrounded by a regular corona of eight radial chambers (*pq*), each with a stigma above and a trachea below. The deep radial furrows between these eight lobes (fig. 7, *pr*) are prolonged to the periphery of the pneumatocyst, which is divided into eight large main lobes. Each of the latter is again divided by a median incision into two secondary lobes, and these again into four tertiary lobules. Thus the entire peripheral part of the float, beyond its equator, is radially lobate. The deep radial furrows of the superior face of the pneumatocyst correspond to high prominent radial crests or lamellar pouches of its concave lower face, and from the height of these lamellar crests arise numerous tracheæ entering into the centradenia. The double wall of the concentric ring-chambers presents therefore a very large surface, by means of the strong development of these radial folds.

Centradenia (figs. 6 and 9, transverse sections; fig. 4, *uc*, meridional section).—The large central gland exhibits in this Porpitid a strange cylindrical form, due to the unusual development of the vertical or longitudinal axis; the latter attains 3 to 4 mm., whilst the horizontal diameter of the cylindrical centradenia is only 1 to 1·5 mm. Its middle part is constricted by the embracing inferior margin of the campanulate pneumatocyst. The radial lamellar crests of the latter fit into corresponding meridional furrows on the surface of the upper head-like part of the centradenia. The lower cylindrical part of this latter is surrounded by the corona of sexual siphons, and its circular basal face is in contact with the basal plate of the sterile central siphon. From the periphery of this plate arise eight radial canals, which are soon forked; an outer main branch runs outwards to the tentacular zone and the umbrella margin; an inner main branch ascends vertically between the convex outer surface of the centradenia and the concave inner surface of the pneumatocyst. These eight centripetal liver-canals unite in the apical pole of the central gland, and form here a regular "liver-star" (fig. 8, *cm*) they give off numerous branches, which form a network in theexodermal parenchyma of the liver; between its branches numerous bent tracheæ are visible.

Central Siphon (*sh*, figs. 2 and 3 in profile, fig. 4 in vertical section, fig. 5 from below, fig. 10 in transverse section).—The large central polypite has an upper pear-shaped part (stomach) and a lower cylindrical part (proboscis). Its length is, in the contracted state, equal to the diameter of the spherical umbrella, and twice as great as its greatest horizontal diameter (near the base). Its thick muscular wall exhibits eight longitudinal exodermal furrows on the outside, and eight corresponding radial entodermal folds on the inside (fig. 10). Between these folds open in the basal part the eight radial canals (fig. 9, *sf*). The distal mouth has eight radial lappets (figs. 3, 4, *so*).

Sexual Siphons (*sx*, figs. 2–5).—A great number of sexual polypites, densely crowded and arranged in four to five concentric rings, occupies the broad basal zone of the subumbrella, between the central siphon and the corona of tentacles; their number may be between sixty and ninety in the smaller, two hundred to three hundred in the larger specimens. The form of these contractile gonostyles is very variable, usually spindle-shaped or pear-shaped. The large sterile central siphon is eight to nine times as long and five to six times as broad as each of the small fertile peripheral siphons. Their mouth is small and exhibits eight radial lappets. The basal part is densely beset with medusiform gonophores.

Tentacles (figs. 2–4, *t*).—The corona of tentacles occupies a broad equatorial zone, nearly half the height of the entire subumbrella. After removal of the tentacles (fig. 3) this zone appears as a convex elegantly reticulated girdle, the concave inside of which embraces the inferior half of the campanulate pneumatocyst (fig. 4, *p*). Each rhomboidal mesh of the reticulum is the basal insertion of one tentacle. There are eight to ten transverse rows of tentacles, one alternating with the other, and each row represents a ring composed of fifty to sixty tentacles, so that their whole number may be four hundred to six hundred. The length of the longest (in the middle zone) surpasses the greatest diameter of the umbrella, whilst the length of those placed in the superior and inferior rows decreases towards the limits of the tentacular zone. The tentacles are slender cylindrical filaments, club-shaped at the distal end, and beset with three rows of cnidospheres (compare above, pp. 38, 39).

Subfamily 2. PORPITELLIDÆ, Haeckel.

Genus 5. *Porpitella*,[1] Haeckel, 1888.

Porpitella, Hkl., System der Siphonophoren, p. 30.

Definition.—Porpitidæ with a flat discoidal umbrella, including a circular discoidal pneumatocyst without marginal lobes. Tentacles numerous, arranged in eight or sixteen prominent radial bunches.

The genus *Porpitella* and the following *Porpita* together make up the subfamily Porpitellidæ, characterised by a discoidal or slightly vaulted umbrella, which includes a discoidal pneumatocyst, the distal margin of the latter being circular, not divided into radial lobes. The numerous marginal tentacles in *Porpitella* are arranged in eight or sixteen regularly disposed radial bunches, whilst in *Porpita* they are equally distributed along the margin of the umbrella.

The new genus *Porpitella* is founded for those species, formerly placed among *Porpita*, which are distinguished by the possession of sixteen radial bunches of marginal

[1] *Porpitella* = Small ring of a buckle, diminutive of *Porpita*.

tentacles. The first species observed was taken by Eschscholtz in the tropical Pacific, and described in 1829 as *Porpita cærulea*.[1] It is probably the species of which Huxley afterwards gave a very accurate anatomical description. Another species of this genus, also taken in the tropical Pacific (near the Marianne Islands), is *Porpita radiata* of Brandt.[2] I have been able to compare the excellent (hitherto unpublished) figure and description left by its discoverer, Mertens. Two specimens of a third species, described in the following pages, were found by me in the Challenger collection, from Station 244. It exhibits in several points a remarkable similarity to the interesting deep-sea Medusa, *Pectanthis asteroides*.[3] I call it therefore after this Trachynemid.

The phylogenetic origin of *Porpitella* is to be found in *Porpalia*. It may be derived from this ancestral form by flattening of the highly vaulted umbrella and the pneumatocyst, which thus become more or less discoidal.

Porpitella pectanthis, n. sp. (Pl. XLVI.).

Habitat.—Station 244, Northern Pacific, between Japan and Honolulu; June 28, 1875; lat. 35° 22′ N., long. 169° 53′ E. Surface.

Umbrella (fig. 1, from above; fig. 2, from below; fig. 3, meridional section).—The disc is a biconvex lens, the horizontal diameter of which amounts to 12 or 15 mm., and is three times as great as its vertical axis (4 to 5 mm.). The meridional section (fig. 3) demonstrates that the larger superior half of the umbrella is occupied by the discoidal pneumatocyst (*p*), the smaller inferior half by the lenticular centradenia (*uc*).

Exumbrella (fig. 1).—The superior or apical face of the umbrella is slightly convex, and exhibits an elegant radial striation, crossed by numerous concentric rings. Sixteen more prominent ribs bear a number of conical papillæ, and between these numerous more delicate, also denticulate, ribs radiate from the centre. The stigmata open at the apex of the conical papillæ. An elegant pigment-star with sixteen brown rays indicates the course of the main ribs.

Limbus Umbrellæ (figs. 3, 7, *um*).—The free margin of the umbrella is prominent at the periphery of the lenticular body, and about one-third or one-fourth as broad as the length of its radius; it is circular, divided by sixteen slight incisions into sixteen flat marginal lobes (fig. 1). Its thickened edge includes a series of marginal glands (fig. 7, *us*).

Subumbrella (fig. 2).—The inferior or basal face of the umbrella is slightly convex, and divided into four different parts of nearly equal breadth. The central part is occupied by the large sterile central siphon; this is surrounded by three circular concentric zones; the first zone is occupied by sixteen smaller sexual siphons (bearing

[1] 1, p. 179, Taf. 16, fig. 5.
[2] 25, p. 40.
[3] Zool. Chall. Exp., part xii. p. 20, pls. vii., viii.

clusters of gonophores); the second zone is marked by the corona of tentacles, divided into sixteen bunches; and the third, outermost, zone is formed by the inferior face of the free peripheral limb.

Pneumatocyst (fig. 4, superior or apical view; fig. 5, inferior or basal view; figs. 3, 6, 7, *p*, meridional sections).—The float, filled with gas, is a circular disc, the horizontal diameter of which (9 to 12 mm.) is ten to twelve times as great as its vertical diameter (1 to 1·2 mm.). Its thickness is nearly equal throughout, or increases a little towards the margin. The superior or exumbrellar face (fig. 4) is slightly convex, and exhibits numerous denticulate radial ribs, sixteen of which are more prominent (fig. 1). Numerous stigmata (*pe*) open by the conical papillæ of the radial ribs. The inferior or subumbrellar face (fig. 5) is slightly concave and radially folded, numerous radial furrows (sixteen of which are deeper) corresponding to the ribs of the upper face. Numerous articulate tracheæ (figs. 5, 6, *pt*; fig. 8) arise from conical protuberances of the inferior ribs, which are prominent between every two radial sulci.

The central chamber of the pneumatocyst (figs. 3, 6, *ph*) opens above by a central apical stigma (*po*), and is surrounded by a regular corona of eight triangular radial chambers; each of these bears a circular stigma (fig. 4, *pe*) on its upper face (placed in variable points), whilst from its lower face arise one or two short tracheæ. The corona of concentric ring-chambers, which surround the girdle of eight radial chambers, is composed of nine to twelve rings. The height (or vertical diameter) of these rings increases from the centre towards the periphery, whilst the breadth (or horizontal diameter) decreases (figs. 3, 7, *pk*). The inner or proximal wall of each ring is concave, the outer or distal wall convex. The concentric rings communicate one with another by eight radial rows of apertures (figs. 3, 4, *pg*), which are placed interradially between the perradial sulci. The innermost or first ring embraces the octoradial chamber-girdle not only from the distal, but also completely from the basal side (figs. 3, 6, *pk*); the other concentric rings embrace one another only from the distal side.

Centradenia (figs. 3, 6, 7, *uc*).—The large central gland (or the so-called liver) is a circular biconvex lens, the horizontal diameter of which (6 to 8 mm.) is three to four times as great as the vertical axis (2 mm.). Its upper surface is in close contact with the concave lower surface of the pneumatophore, its lower surface with the subumbrella. Numerous radial ribs of the upper surface fill up the radial sulci of the lower surface of the pneumatophore. The brown liver vessels are very densely crowded in the upper half, loosely scattered in the lower half of the pneumatophore. All these hepatic canals unite on the lower surface of the centradenia into descending canals, which pierce the fulcrum of the subumbrella; eight of these (forming an inner girdle of openings) open into the peripheral part of the base of the central siphon; sixteen others (forming an outer girdle) open into the sexual siphons (*sx*). The majority of the canals of the central gland contains in their epithelium that black pigment which is regarded as "hepatic

granules"; whilst another part is colourless or more or less filled up with guanin-crystals ("renal granules"). The uppermost canals (between the pouches of the pneumatocyst) are colourless.

Central Siphon (figs. 1, 2, 3, *sa*).—The large sterile central polypite has the usual form of a thick-walled cylindrical or inversely conical tube. Its dilated base occupies the centre of the subumbrella, and is separated from the centradenia by a thick fulcrum or supporting lamella, the gastrobasal plate; it exhibits a peripheral ring of eight openings, leading into the eight radial main vessels (compare p. 31).

Sexual Siphons (fig. 2, fig. 3, *sx*).—The sixteen peripheral polypites form a regular corona around the base of the large central polypite, and are separated by a circular furrow from the corona of tentacles. They bear numerous gonophores on their thinner basal part, whilst their spindle-shaped distal part opens by a four-lobed mouth (compare p. 37).

Tentacles (figs. 1–3, *t*).—The numerous tentacles form a submarginal corona, which occupies about one-third of the subumbrella. They form six to eight concentric rows, and exhibit a very different length. Seen from above or below the corona presents sixteen elegant rays, each of which is composed of an adradial bunch of larger tentacles. The longest tentacles (in the middle of each radial bunch) surpass the diameter of the umbrella in the contracted spirit specimens, and may be much longer in the living animal. The form and structure of the tentacles, with three rows of cnidospheres, is that which is usual in all Porpitidæ (compare pp. 38, 39).

Genus 6. *Porpita*,[1] Lamarck, 1816.

Porpita, Lmk., Hist. nat. anim. s. vert., t. ii. p. 483.

Definition.—Porpitidæ with a flat discoidal umbrella, including a circular discoidal pneumatocyst without marginal lobes. Tentacles very numerous, equally disposed in several concentric circles, not forming radial bunches.

The genus *Porpita* possesses the same flat discoidal umbrella, and the same circular, not radially lobate, pneumatophore, as the preceding genus *Porpitella*; but it differs from the latter in the equal distribution of the tentacles along the whole margin of the umbrella. The tentacles are very numerous, and densely crowded in several parallel circles (as in *Porpema*), and they are not grouped into radial lobes.

The genus *Porpita*, hitherto regarded as the only representative of the family Porpitidæ, was founded in 1816 by Lamarck upon the first known species, which Forskål had observed in the Mediterranean, and described very accurately as *Holothuria denudata*.[2] Eschscholtz, the founder of the class Siphonophoræ, in 1829 placed *Porpita* in his family Velellidæ, and gave the following definition:[3]—"Corpus orbiculare, supra

[1] *Porpita* = Ring of a buckle, πόρπη.

[2] 11, p. 103, Taf. 26, fig. L 1.

[3] 1, p. 176, Taf. 16.

inerme. Tentacula marginalia trifariam glandulosa." He described five different species. Two of these only appertain to the genus *Porpita* as above defined (*Porpita mediterranea* and *Porpita umbella*).

The best and most accurate anatomical descriptions of the genus are those given in 1853 by Kölliker of *Porpita mediterranea* (4), and in 1881 by Alexander Agassiz of the North Atlantic *Porpita linnæana* (57). Closely related to the latter is probably the tropical Atlantic *Porpita umbella* of Eschscholtz (1). The collection of the Challenger contains several specimens of a new species, taken in the Northern Pacific, and figured in Pl. XLV. as *Porpita fungia*. Three other distinct species seem to be *Porpita lütkeana* (25), from the Indian Ocean; *Porpita pacifica* of Lesson (22); and a new southern form, *Porpita australis*.

The phylogenetic origin of *Porpita* is to be found in the preceding genus, *Porpitella*, from which it is derived by multiplication and equalisation of the tentacles, not forming separated radial bunches.

Porpita fungia, n. sp. (Pl. XLV.).

Habitat.—Stations 253 to 255, Northern Pacific, between Japan and Honolulu; 14th to 19th July 1855; lat. 38° 9′ N. to 32° 28′ N., long. 156° 25′ W. to 154° 33′ W. Surface.

Umbrella (fig. 1, meridional vertical section).—The disc is flat, circular, of equal thickness throughout nearly its whole extent, like a coin. Its diameter is usually 20 to 25 mm., but amounts in the largest specimens to 30 mm.; its thickness (without the siphon and tentacles) is 4 to 6 mm. A meridional section (fig. 1) demonstrates that three-fourths of the thickness belong to the centradenia, one-fourth to the pneumatocyst.

Exumbrella (fig. 2).—The superior or apical face of the umbrella is flat or slightly convex, a little depressed in the centre. It is covered with numerous, irregularly scattered, conical tubercles, arising from the upper face of the pneumatocyst. Their number and size increase towards the centre. The peripheral half of the exumbrella is pierced by numerous irregularly scattered stigmata (*pe*). The regular octoradial striation and the numerous concentric rings, which shine through the silvery exumbrella, are due to the structure of the subjacent pneumatocyst. An elegant network of anastomosing canals, with narrow irregular polygonal meshes, is expanded everywhere in the exumbrella.

Limbus Umbrellæ.—The free membranous border or limbus of the umbrella overlaps the tentacular zone to the extent of 1 to 2 mm. It is flatly expanded or reflected upwards, and includes a series of marginal glands of the usual form (compare above). The numerous canal-branches of the exumbrella anastomose richly, form an irregular network, and unite in a circular canal inside the glandular corona; and from this arise the vessels of the centradenia and the subumbrella.

Subumbrella (fig. 1).—The inferior, distal or basal face of the umbrella is divided into four different zones. The central zone, with a diameter of 3 to 4 mm., is occupied by the gastrobasis or the fundus of the large central siphon. The broad middle or gonostylar zone (4 to 6 mm. in breadth) is occupied by the numerous sexual siphons or gonostyles. The third or tentacular zone (2 to 3 mm. broad) bears the numerous tentacles. The fourth or outermost zone (1 to 2 mm. broad) is formed by the inferior face of the free mantle-border.

Pneumatocyst (fig. 1, fig. 5, *pf*).—The float, filled with air, is a flat circular disc of 15 to 20 mm. diameter. Its thickness increases considerably from the centre towards the margin, owing to the height of numerous radial folds. The form of the pneumatocyst presents a great resemblance to a regular *Fungia*, the disc being folded radially in a very regular manner. The vertical folds arise in the upper surface in eighty or ninety high radial ridges, with deep valleys between them, whilst branched radial lamellæ are prominent on the lower face.

The octoradial structure of the pneumatocyst is very distinct on its upper face, since the eight equidistant primary rays are more prominent than all the others. They arise from the septa of the eight radial chambers which surround the central chamber. The octant between every two primary folds is bisected by a secondary ray, somewhat less prominent, but also stronger than all the others. Sixteen tertiary or adradial ridges arise in the middle between the eight primary and the eight secondary rays. The other rays are developed in the peripheral half of the disc only. The total number of radial ribs is about eighty in a specimen of 15 mm. diameter, one hundred and twenty in a larger specimen of 20 mm. The most elevated part of each radial rib bears a radial series of stigmata. The number of concentric annular septa is about fifty in the former, eighty in the latter. These are wider (about twice as broad) in the middle part of the disc than in the central and the peripheral part.

The thickness of the chitinous wall of the air-chambers is much greater in the upper than in the lower face, and it increases from the periphery of the disc towards the centre. It equals in the central half of the disc the height of the air-chambers. Numerous strata of chitinous substance are here deposited as secondary supports of the disc-wall, and have closed the stigmata (fig. 1, p^2). The conical tubercles of the surface of the disc are produced by stronger deposits at separate places (p^1). The stigmata of the air-chambers remain open in the peripheral part of the disc only (*pe*); they are urn-shaped, very numerous, and irregularly scattered in radial rows (fig. 2, *pe*).

The lower face of the pneumatocyst, which is in close contact with the centradenia, is more strongly folded than the upper face; the folds are here ramified centrifugally, and form high triangular lamellæ, the height and number of which increase from the centre towards the periphery (fig. 1, p^4). Eight primary radial lamellæ, arising from the septa of the eight pericentral radial chambers, are more prominent than the eight secondary

alternating, and these more than all the other lamellæ. The centrifugal dichotomous ramification of the lamellæ increases gradually towards the periphery, and new peripheral folds are interposed between the centrifugal folds, so that their number at the margin of the disc is much greater than that of the simple radial ridges of the upper surface. The crest of the folds is elegantly denticulate, and from it arise two opposite radial rows of tracheæ. The tracheæ or aëriferous tubules in this *Porpita* are exceedingly numerous, amounting to many thousands. The majority of them are short and end half way up the centradenia. A smaller number pierce the latter and the subjacent support, and project into the exodermal wall of the central siphon and the surrounding gonostyles. They terminate here in the basal half of the latter, inside the exodermal epithelium (fig. 8, *pt*).

The circular concentric ring-chambers of the pneumatocyst communicate one with another by radial apertures or "pneumothyræ," oblique elliptical openings, which are placed in the radial sulci between the folds of the lower face.

The central chamber possesses, as usual, a central stigma in its upper face, as does also each of the surrounding eight radial chambers. From the basal part of each of the latter arises a bunch of three or four short tracheæ. In the basal sulci between these are eight openings, which lead into the first ring-chamber.

Centradenia (fig. 1, *uh*, meridional section; fig. 3, inferior face; figs. 6–8, *un*, parts of sections).—The large central gland (or the so-called "liver") is a biconvex lenticular disc, the horizontal diameter of which is four times as great as its vertical axis; the latter measures in a specimen of 20 mm. diameter (umbrella) 3 mm., the former 12 mm. Its superior face has a regular radiate appearance; innumerable radial folds (thirty-two of which are stronger) fitting into the radial grooves which lie between the lamellar pouches of the inferior face of the pneumatocyst. The height of these folds increases from the centre towards the periphery. The circular margin meets the line which marks the boundary between the gonostylar and tentacular zones.

The inferior face of the centradenia is less convex than the superior, and is divided into a white central disc (kidney) and a peripheral brown radiate zone (liver). The former covers the roof of the central siphon (*sa*), and surrounds it like a broad, white girdle (fig. 3, *un*); the peripheral part of the brown liver (fig. 3, *sh*) surrounds again the former as a dark radiate ring. The gonostyles arise as well from the former as from the latter.

The meridional or vertical section of the centradenia (fig. 1) demonstrates that its solid exodermal parenchyma is traversed by a dense network of innumerable canals, the greater part of which are darkly coloured by a brown (hepatic) pigment. This is wanting in a part of the superficial canals, and in the inferior white central disc ("kidney"), which contains masses of guanin-crystals. Innumerable tracheæ terminate between the canal branches; their distal openings being surrounded by (air-secreting?) exoderm cells (compare the explanation of figs. 6–8).

Central Siphon (fig. 1, *sm*, fig. 4).—The large sterile central polypite is inversely conical, in the contracted state about as long as the diameter of its broad base, which is a quarter or a fifth of the diameter of the umbrella. Its thick muscular wall exhibits sixteen longitudinal folds, and between these run sixteen deep grooves, which open at the bottom of the stomach into the sixteen radial main canals. The distal mouth of the central siphon is octolobate. Its opposite proximal roof is separated by a strong fulcrum or supporting lamella, the gastrobasal plate (fig. 1, *st*), from the superjacent kidney.

The sixteen radial main canals, which arise from the periphery of the base of the stomach, run along the subumbrella towards the peripheral edge of the limb, where they are united in a circular marginal canal. They give off innummerable branches; of these the ascending ones enter into the centradenia, the descending partly into the gonostyles, partly into the tentacles. Numerous superficial mantle-vessels arise from the marginal canal and enter centripetally into the exumbrella, where they form an irregular dense network above the pneumatocyst.

Sexual Siphons (figs. 1, 8, *sx*).—The gonostyles cover the greatest part of the subumbrella, and are densely crowded in the broad zone which lies between the central siphon and the tentacular zone. Their number amounts to several hundreds. They are covered with bunches of gonophores in the cylindrical proximal half, with patches of cnidocysts in the spindle-shaped distal half. Their distal mouth is often divided into four or eight small lobes.

Tentacles (fig. 1, *t*).—The tentacular zone of the subumbrella, inside the free prominent limb, is about as broad as the base of the central siphon. It presents an elegant reticulum, with rhomboidal meshes, when the tentacles are removed; each mesh being the base of a detached tentacle. These are arranged in six to eight concentric rows. In the largest specimens their number exceeds one thousand. Their length may exceed the diameter of the umbrella; the majority, however, are much shorter. The structure of the club-shaped tentacles is the usual one, with three rows of stalked cnidospheres (compare p. 39).

Family III. VELELLIDÆ, Eschscholtz, 1829.

Velellidæ, Eschscholtz, System der Acalephen, p. 165 (*sensu restricto*).

Definition.—Disconectæ with an elliptical or amphithect, often nearly quadrangular umbrella, including a polythalamous pneumatocyst of the same form, which is composed of numerous concentric rings, and usually bears in its diagonal a vertical crest. Always a membranous vertical sail upon the umbrella. Marginal tentacles simple, without cnidospheres. Central siphon surrounded by numerous peripheral fertile siphons, which bear the gonophores.

The family Velellidæ, founded by Eschscholtz in 1829, comprised originally all Dis-

conectæ, or all the "Medusæ chondrophoræ" of Chamisso and Eyssenhardt. Afterwards (in 1835) Brandt separated the true Velellidæ (with elliptical disc and vertical crest) from the Porpitidæ (with circular disc, without crest). The Velellidæ, thus restricted, agree with the Porpitidæ in the polygastric structure, not only the large sterile central siphon possessing an open mouth at its distal end, but also each of the surrounding gonostyles. These peripheral polypites, which bear the gonophores budding from their proximal part, are therefore not mouthless palpons (as in the Discalidæ), but mouth-bearing, feeding, and digesting secondary siphons. On the other hand, the Velellidæ differ from the Porpitidæ (as well as from the Discalidæ) in the peculiar amphithect or bilaterally-radial ground-form of the body, produced by the prolongation of the sagittal axis, and shortening of the frontal axis; and, further, in the development of a peculiar vertical crest or sail, which arises from the exumbrella either in the sagittal or in a diagonal axis.

Eschscholtz, in his fundamental work,[1] divided his Velellidæ into three genera:—*Rataria*, *Velella*, and *Porpita*. The genus *Rataria*, however, was considered by the majority of subsequent observers to consist only of young forms of *Velella*. A new species of *Rataria*, found in the Challenger collection, proved to be an autonomous genus, provided with gonophores. Although the different *Ratariæ*, described by some authors, may be merely young *Velellæ*, there nevertheless exist also Velellidæ which become mature in the permanent *Rataria*-form. The numerous species of the true *Velella* were disposed in my System (p. 31) in two genera:—*Velella* (*sensu restricto*), with an elliptical umbrella and simple corona of tentacles; and *Velaria*, with quadrangular umbrella and double or multiple corona of tentacles. For this latter the old name *Armenista* (or *Armenistarium* of Carburius, 1757) may be better retained.

Umbrella.—The common trunk of the cormus, which corresponds to the umbrella of a hydromedusoid person, is in all Velellidæ a flat, horizontally expanded, and floating disc, distinguished from the circular disc of the Porpitidæ and Discalidæ, firstly, by its bilateral form, and secondly, by the vertical crest or sail. The latter is originally nothing more than a simple longitudinal fold of the exumbrella, and may be regarded as the primary cause of the peculiar fundamental form. The three genera which we have distinguished represent three different degrees or historical steps in its peculiar development:—*Rataria*, next to the ancestral group Porpitidæ, has an elliptical disc, and the sail placed in its sagittal plane, in the longer axis; in *Velella* the sail turns a little around the vertical main axis, and comes to be situated in a diagonal axis of the disc; finally, in *Armenista* the disc becomes quadrangular or parallelogram-shaped. Besides, a vertical crest of the pneumatocyst, as a support of the soft sail, is developed in the two latter genera, but is wanting in *Rataria*.

Amphithect Fundamental Form.—The peculiar fundamental form presented by the

[1] 1, 1829, p. 166.

umbrella of the Velellidæ may be called either amphithect or bilaterally-radial. It is characterised by three unequal dimensive axes, each perpendicular to the other two; one being allopolar (with unequal poles), the other two isopolar (with equal poles). The allopolar axis is the vertical main axis, its upper or apical pole determined by the top of the sail, its lower or basal pole by the mouth of the central siphon. The greater isopolar axis is the sagittal axis of the disc (the major axis of the ellipse), which divides it into two equal symmetrical halves, right and left. The smaller isopolar axis is the transverse or frontal, which is perpendicular to the latter, and separates the disc also into two equal halves, dorsal and ventral; it corresponds to the minor axis of the ellipse.

The *octoradial character* of their amphithect ground-form is always indicated by the origin and course of the eight primary gastro-canals, which arise from the base of the central siphon; secondly, it is marked by the centre of the pneumatophore, which exhibits more or less distinctly eight radial chambers around the simple central chamber; thirdly, it is often indicated by the radial arrangement of eight primary marginal tentacles and of other parts. The umbrella of the Velellidæ is therefore composed originally of eight equal parameres (or homotypical radial parts), like that of the Porpitidæ and Discalidæ; but it differs from that of the latter in the fact that the parameres are disposed in pairs, so that the disc may be regarded also as composed of four paired quadrants; and sometimes the limits of these are sharply marked off by four marginal incisions of the pneumatophorous disc.

The quadriradial appearance, the body seeming to be composed of four parameres (as in the most Medusæ), is mainly obvious in the more highly developed Velellidæ. But regarding their phylogenetic origin from the Porpitidæ, we must assume that this fundamental form has arisen from a true octoradial type composed of eight parameres. In no case can we regard this fundamental form as uniradial, a point of view which is represented by Chun.[1] I agree perfectly with the explanation of the origin of the sail which Chun there gives (*loc. cit.*, p. 15); but I cannot agree with his promorphological deductions. I cannot concede at all that uniradial fundamental forms exist anywhere.

A *true asymmetry*, mentioned by many authors in the umbrella of the Velellidæ, does not exist; for in every case the two halves of the body, which are separated by any possible meridional section (through the vertical main axis), are perfectly equal; and the dorsal and ventral halves cannot be distinguished by any character; the right and left halves being likewise equal one to another. The so-called "asymmetry" in the disc of many Velellidæ is only the beginning of a spiral twisting, caused by a slight dislocation of the vertical sail, turning more or less around the vertical main axis. But in the elliptical *Rataria* (and also in the similar Ratarula-larvæ of *Velella* and *Armenista*) the sail is placed in the sagittal plane, and its later dislocation from this plane is a secondary alteration, comparable to the turning of the sail in a boat sailing before the wind.

[1] Chun, Fauna and Flora des Golfes von Neapel, i., Ctenophoren, 1880, p. 14.

This *sail*, or the vertical crest of the Velellidæ, is the most characteristic part of their trunk, and its gradual development is the primary cause of their peculiar amphithect form. The sail is originally nothing other than a small fold of the exumbrella, or the soft upper lamella of the disc. We may assume that the elevation of such a fold in any ancestral Porpitidæ was very useful as an aid to the locomotion of the pelagic animal floating on the level of the sea by its horizontal disc. Natural selection, therefore, will have increased the height of that crest, driven by the wind, and the immediate effect must have been the transformation of the circular disc into an elliptical one, the sail occupying the major axis of the ellipse (*Rataria*). Afterwards the soft and contractile sail becomes supported by the development of an inner chitinous crest, arising from the pneumatophore (*Velella*), and finally the whole outline of the disc, and the arrangement of its marginal parts, assumes the form of a parallelogram, and the sail is placed in its diagonal axis (*Armenista*). A continuous series of intermediate, transitional forms conducts us from the elliptical *Rataria* (with sagittal sail), through different forms of *Velella*, to the most specialised parallelogram-shaped *Armenista* (with diagonal veil). The special form of the sail in the two latter genera depends upon that of the supporting firm crest of the pneumatophore; in *Rataria*, however, where the skeleton-crest is wanting, its form differs greatly according to its varying state of contraction.

Exumbrella.—That part of the trunk which includes the pneumatocyst, and corresponds to the invaginated exumbrella, is composed in the Velellidæ, as in the other Disconectæ, of two parallel membranes connected by branched septa. The outer membrane, or the permanent exumbrella (the uninvaginated part), is the pneumatocodon; its exodermal epithelium is armed with many cnidoblasts, and beyond it is placed a strong muscular plate, composed of longitudinal or radial fibres. The inner membrane, or the invaginated part of the exumbrella, is the pneumatosaccus; its thinner exodermal epithelium envelops like a complete sac the whole surface of the pneumatocyst, and this is nothing more than the hardened chitinous cuticula secreted by the former. A great number of septa connect both membranes, and between them occur the canals of the exumbrella, more radially in the horizontal surface of the disc, more longitudinally and parallel in the vertical surface of the sail (on both sides of it). These pallial canals open in the periphery of the horizontal disc into the marginal canal, and along the free margin of the sail into a crescentic canal, running along the whole margin.

Pneumatocyst.—The chitinous polythalamous float filled with air, which we call pneumatocyst (usually called the "inner shell"), always assumes the form of its surrounding matrix, the pneumatosaccus. It is, therefore, in the Velellidæ elliptical or quadrangular, and very different from that of the Porpitidæ and Discalidæ, where it is always circular and regularly octoradial. Since, however, the former have arisen originally from the latter, their pneumatocyst also must be regarded as an amphithect or bilateral modification of that circular float of the latter. Indeed, in all Velellidæ there are traces, more or

less distinct, of the same octoradial composition of the centre of the float, which is immediately evident in all Porpitidæ and Discalidæ.

The pneumatocyst of *Rataria* consists only of a horizontal, slightly campanulate or flatly conical disc of elliptical outline, whilst that of *Velella* and of *Armenista* bears a solid vertical triangular crest, placed in a diagonal axis of the disc.

The pneumatocyst of *Rataria* is of the highest interest, since it offers all desirable intermediate forms between the bilateral crested float of the other Velellidæ and the circular crestless float of the Porpitidæ. This is the more important, as the young Ratarula-larvæ of *Velella* and *Armenista* exhibit the same structure of the pneumatocyst (during a longer or shorter time) which is permanent in the autonomous genus *Rataria*. A central chamber, placed in the centre of the exumbrella, is here always surrounded by eight radial chambers, just as in the Porpitidæ and Discalidæ. But whilst in these two families each radial chamber (as well as the central chamber) possesses a stigma, or a free opening on its upper surface, there are in the similar pneumatocyst of *Rataria* three such openings only, one in the upper face of the central chamber and one on each side of it, in the two chambers, which are directed towards the two sagittal poles, or the poles of the major axis of the ellipse. The stigmata of the six other chambers seem to be lost by phylogenetic reduction (Pl. XLIV. fig. 8). Each of the eight radial chambers usually possesses a trachea or a bunch of descending air-tubules on its lower face (fig. 9).

The octoradial structure of the pneumatocyst, which is obvious in *Rataria*, is also recognisable in the similar Ratarula-larvæ of *Velella* and *Armenista*. But it is not equally distinct and well preserved in all species of these two genera. The peripheral wall of the central chamber, which separates it from the eight surrounding radial chambers, is pierced by eight openings, connecting the former with the latter. These openings of communication afterwards often become so enlarged that the eight chambers appear only as radial lobes of the central chamber, and sometimes the eight radial septa between the former are so reduced that the eight lobes nearly disappear. This fact explains the striking contradictions of the former observers, some of whom interpret the Ratarula-larvæ as young forms of Velellidæ (Huxley, Bedot, &c.), some as larvæ of Porpitidæ (Agassiz, Burmeister, &c.).[1] Indeed all these larvæ belong to the Velellidæ, since the larvæ of the Porpitidæ never develop a vertical sail. But the octoradial structure of the central part of the pneumatocyst, which is always very distinct in the latter, is of very variable distinctness in the former; sometimes it is well preserved, at other times not, and sometimes the cenogenetic modification is so strong that it becomes quite lost.

The *concentric ring-chambers of the pneumatocyst*, which surround its octoradial central part, are not circular in the Velellidæ (as in the Porpitidæ and Discalidæ), but more or less elliptical, with prolonged sagittal axis, and shortened transverse or frontal

[1] Compare Pagenstecher, 55.

axis. The ellipses are short and nearly circular in the young *Rataria;* they become longer and sometimes slightly quadrangular in *Velella*, and completely parallelogram-shaped in *Armenista*. The number of these concentric ring-chambers is very variable in the different species, two to eight only in the smallest species (*Rataria*), twenty to thirty or more in the larger (*Velella*), and fifty to eighty or more in the largest forms (*Armenista*).

Pneumothyræ.—The concentric ring-chambers of the pneumatocyst are all in open communication one with another. Each annular elliptical septum between two chambers is pierced by two opposite openings or septal pores, one in the dorsal half, the other in the ventral half of the disc. All these septal pores are placed in a straight line, cutting the major axis of the disc at a very small angle, as was first shown by Kölliker.[1] There are, therefore, not eight radial rows of pneumothyræ as in the ancestral Porpitidæ, but only two opposite radial rows. In some species of Velellidæ, however, there seem to exist two other opposite rows, placed in a transverse line near the frontal groove.

Stigmata.—All Velellidæ possess a relatively small number of superficial openings on the ring-chambers, which lie at their apical or superior surface, and serve for the emission of gas. The number of these stigmata is much smaller than in the Porpitidæ. Usually only every third or fourth ring possesses a pair of opposite stigmata; sometimes rings with and without stigmata alternate regularly; rarely each ring possesses one pair. All the gas-pores or stigmata discovered by Kölliker lie in a straight line, just as do the septal pores, and the line of the former is placed between the line of the latter and the base of the vertical crest. Half the stigmata, therefore, lie in the ventral half of the disc on the right side of the crest, and the other half in the dorsal half on the left side, or *vice versa* (compare Pl. XLIII. fig. 5, *pe*). The direction of the series of stigmata in all Velellidæ is already marked by the three first stigmata of their Ratarula-larvæ. These, as well as the mature *Rataria* (Pl. XLIV. fig. 8), possess only three stigmata, which are placed in a line, cutting the sagittal axis of the horizontal disc at an acute angle; one of the three pores lies near the centre (*po*); the second on the left (*pe*), and the third on the right side. All the following stigmata develop in the direction of that line. In many Velellidæ the stigmata lie so near the crest-basis that they are difficult to find.

Tracheæ.—The number of tracheæ arising from the lower face of the pneumatocyst in the Velellidæ is also much smaller than in the Porpitidæ, but they are longer than in the latter and usually branched. In many species eight tracheæ arise from the periphery of the eight radial chambers which surround the central chamber; these are usually branched (Pl. XLIII. fig. 6; Pl. XLIV. fig. 9). A small and variable number of other tracheæ arise here and there, irregularly scattered, from other parts of the pneumatocyst.

The vertical crest of the pneumatocyst, or the sail-skeleton, wanting in *Rataria*, exhibits different degrees of development in the various species of *Velella* and *Armenista*.

[1] Kölliker, 4, Taf. xi. fig. 11.

At first it is a low thin crest in the base of the soft muscular sail, and afterwards arises as a high vertical lamella, usually of more or less triangular form; the top of the triangle is the highest point of the body, and placed in the upper or apical pole of the vertical main axis. The broad base of the triangle, placed in one diagonal line of the parallelogram-shaped disc, is usually about one and a half times as long as each of the two equal lateral sides. The substance of the crest is a thin chitinous plate, secreted from that part of the pneumatosaccus which arises from the diagonal of the disc as a vertical fold. It is perfectly homogeneous, solid, and structureless, and contains no canals nor air-chambers. A number of lines or thin ridges, parallel to the two ascending edges of the triangular crest, and visible on both flat sides of it, indicate its successive growth.

Central Siphon.—The large central polypite of the Velellidæ differs from that of the Porpitidæ and Discalidæ in its bilateral compression; the transverse section of its basal part is circular in the two latter families, elliptical in the former; the major axis of the ellipse corresponds to that of the umbrella. Its general structure and shape are otherwise the same as in the other Disconectæ. The central siphon is comparatively large in the small *Rataria*, where the number and size of the peripheral siphons is small, whereas in the larger species of *Velella* and *Armenista*, where the peripheral siphons are very numerous, the central polypite is less preponderant. The thick wall of the central siphon is very contractile, and composed of two strong muscle-plates, an outer longitudinal and an inner circular, both separated by a strong elastic fulcrum. The wall often exhibits prominent radial or longitudinal folds, eight in the smaller, sixteen or more in the larger forms. Correspondingly, the terminal mouth is often four-lobed or eight-lobed (Pl. XLIII. figs. 4, 8, *so*; Pl. XLIV. figs. 2–5, *so*).

Centradenia.—The large central gland, or the so-called "central organ" (formerly "liver"), exhibits the peculiar composition described above (p. 31). Bedot has given an accurate histological description of its structure (59, 60). In the Velellidæ it is more developed than in the Discalidæ, but much less than in the Porpitidæ. It does not usually occupy the greater part of the superior face of the subumbrella as in the latter, but only its central part, between the centre of the float above and the base of the large central siphon below. The outline and the horizontal section of the centradenia are not circular, as in the Porpitidæ and Discalidæ, but elliptical or lanceolate, the major axis of the ellipse corresponding to that of the umbrella. Its superior or apical face is more or less conical, and fills up the concave inferior face of the pneumatocyst. Its inferior or basal face is even, separated by the gastrobasal plate from the base of the central siphon. The difference between the hepatic vessels in the superior half of the central gland, and the renal vessels in its inferior half, seems to be usually not so striking in the Velellidæ as in the Porpitidæ. The canal-plexus, as well as the compact parenchyma of exoderm cells, which fills up the interstices of the canal-network, and probably secretes the gas, is in the former far less developed than in the latter. This weaker development of the

centradenia in the Velellidæ is probably due to their pelagic habit of life, and the development of the vertical sail as an excellent means of passive locomotion. The Porpitidæ, on the other hand, are probably inhabitants of different depths, and only occasionally come to the surface; their hydrostatic apparatus and the gas-secreting gland are therefore more developed.

Gonostyles.—The numerous polypites of the subumbrella, which produce by budding the medusiform gonophores, are in the Velellidæ mouth-bearing siphons, as in the Porpitidæ, not mouthless palpons as in the Discalidæ. They are, therefore, usually called "smaller polypes," "sexual polypites," or "peripheral siphons" (shortly "peri-siphons"). They occupy usually, densely crowded in great numbers, a broad gono-stylar zone, and often the whole space of the subumbrella between the central siphon and the submarginal corona of tentacles. But at first their number seems to be restricted to eight or sixteen; at least this is the case in *Rataria cristata* (Pl. XLIV. fig. 2), and also in some similar young larvæ (Ratarula) of *Velella*. Their form and structure are the same as in the Porpitidæ, already described above (p. 36).

Tentacles.—The corona of submarginal tentacles is in the Velellidæ far less developed than in the Porpitidæ; their structure, too, is simpler than in the latter. The corona is simple, composed of a single series of filaments in *Rataria* and *Velella;* it is double or multiple, and composed of two or three (seldom more) series in *Armenista*. Their number is probably originally eight, and this occurs in some Ratarula-larvæ; but there are other similar larvæ in which the corona bears a variable number of tentacles irregularly disposed. Some very small and young larvæ of the Ratarula-form exhibit only two tentacles, at opposite poles of the major axis of the ellipse, and corresponding to the two primary stigmata of the pneumatocyst.[1] The only *Rataria* which I have observed in the adult state (with gonophores) possessed sixteen tentacles, rather regularly disposed along the limb (Pl. XLIV. figs. 1, 2). In *Velella* this number is soon increased, and amounts in the simple series usually to fifty to eighty, often more than a hundred. In *Armenista* there are usually some hundreds, or sometimes thousands; the smaller tentacles of the outer (or distal) series alternating with larger filaments of the inner (or proximal) series.

Form of the Tentacles.—The general structure of the tentacles in the Velellidæ is the same as in the Porpitidæ, but their form is much simpler, and the three rows of stalked cnidospheres, which are characteristic of the tentacles of the latter family, are wanting. The submarginal filaments of all Velellidæ are simple cylindrical tubes, sometimes slightly compressed, usually gradually tapering towards the rounded distal end, seldom somewhat club-shaped; in very young larvæ they are conical and pointed. Their armature with cnidoblasts is very different from that of the two other families. Usually each tentacle bears only two lateral ribands of cnidoblasts, sometimes four (two stronger

[1] Compare Bedot, 60, 1884.

lateral and two weaker medial, an upper and a lower). The cnidoblasts are often more crowded towards the distal end. Sometimes they are irregularly scattered.

Ontogeny.—The larvæ of the Velellidæ were described by Eschscholtz,[1] who founded upon them the new genus *Rataria*. We retain here this genus for those simplest forms of the family, which, at this same stage, develop a corona of sexual siphons around the central siphon, and gonophores from the gastral walls of these gonostyles. The larval forms of *Velella*, described usually as *Rataria*, lack the gonostyles, and are better designated as *Ratarula*. Pagenstecher (**55**) has given a careful historical and anatomical description of these larval forms. But I suppose that the numerous larvæ examined by him, and all figured as *Rataria*, may be mixed larvæ of *Velella* and *Porpita*. The regular octoradial pneumatocyst, figured in his Taf. xli. fig. 1, seems to belong to *Porpita*, since the same organ in *Velella* is always more or less amphithect or bilateral. But no larva of *Porpita* has the vertical sail or crest shown in his figs. 3–5, &c.; these belong to *Velella*.

The medusiform gonophores, which bud in clusters from the gonostyles of the Velellidæ, and afterwards become detached (*Discomitra*, *Chrysomitra*), are described by many authors (mainly by Kölliker, **4**, Vogt, **5**, Gegenbaur, **7**, Leuckart, **8**, Huxley, **9**, Alexander Agassiz, **57**, and others (compare on the metagenesis of the Velellidæ, p. 39 above).

Phylogeny.—The Velellidæ have probably descended from the older forms of Porpitidæ (or directly from the Discalidæ); their peculiar amphithect or bilateral development is due to the production of the vertical sail as a longitudinal fold of the exumbrella.

Synopsis of the Genera of Velellidæ.

1. Umbrella elliptical, with integral margin. Pneumatocyst without crest. Corona of tentacles simple, ... 7. *Rataria*.
2. Umbrella elliptical or quadrangular, with integral margin. Pneumatocyst with a crest. Corona of tentacles simple, ... 8. *Velella*.
3. Umbrella quadrangular, with a lobate margin. Pneumatocyst with a crest. Corona of tentacles double or multiple, ... 9. *Armenista*.

Genus 7. *Rataria*,[2] Eschscholtz, 1829.

Rataria, Esch., System der Acalephen, p. 166.

Definition.—Velellidæ with an elliptical umbrella and a vertical membranous sail placed in the major axis of the ellipse. Margin of the umbrella not lobate. Pneumatocyst flatly campanulate or more discoidal, elliptical, without vertical chitinous crest. Submarginal corona of tentacles simple.

The genus *Rataria* is the simplest and most primitive form of the Velellidæ, and

[1] 1, p. 166. [2] *Rataria*=A float.

comprises those small forms of the family, the vertical sail of which contains no chitinous crest. The pneumatocyst, therefore, is the horizontal elliptical chitinous disc alone; no vertical skeleton crest is developed upon its surface, as in *Velella* and *Armenista*. The soft vertical sail is placed in the major axis of the ellipse, not obliquely in a diagonal. The species of *Rataria* upon which Eschscholtz founded the genus were probably young larval *Velellæ*, perhaps the same as those of which Bedot has during the last few years given an anatomical description (58–62). Pagenstecher gave in 1863 a very accurate description of *Rataria*, with historical remarks on the Velellidæ in general, and discussed the question whether these forms of Disconectæ were only a larval stage of *Velella* (or perhaps of *Porpita*) or an independent peculiar genus of this group. As a fact both alternatives are true. *Rataria cristata*, from the Tropical Atlantic, described in the following pages, and found in the Challenger collection (Station 348), is a Velellid which produces gonophores in the form of *Rataria*, and therefore is the representative of an independent genus. The larvæ of *Velella* and *Armenista*, on the other hand, all pass through a larval stage similar to the former. But no Porpitidæ have a similar larval form, since the vertical sail is completely wanting in this family, and is only to be found in the family Velellidæ. Regarded from a phylogenetic point of view, *Rataria* is a necessary intermediate link between the older *Porpita* and the more modern *Velella*.

Rataria cristata, n. sp. (Pl. XLIV.).

Habitat.—Station 348, Tropical Atlantic; April 9, 1876; lat. 3° 10′ N., long. 14° 51′ W. Surface.

Umbrella (fig. 1, from above; fig. 2, from below; fig. 3, half lateral, half apical view; fig. 4, lateral view; fig. 5, frontal section).—The horizontal disc of the umbrella is elliptical, 4 mm. long and 3 mm. broad in the expanded state. The vertical sail which arises in its sagittal or longitudinal axis, is very contractile, and therefore exhibits very different forms (figs. 3, 4). The vertical transverse section of the umbrella (fig. 5) demonstrates that the greatest part of its volume is occupied by the pneumatocyst (*pf*), and the centradenia (*uc*) which lies between this and the central siphon (*sa*).

Exumbrella (figs. 1, 3, 4).—The superior or apical face of the umbrella is divided into three parts—the vertical sail (velarium), the campanulate part, which includes the pneumatocyst (pneumatophore), and the broad horizontal free border (limbus).

Limbus Umbrellæ (*uu*).—The peripheral border of the horizontal disc, which surrounds the campanulate pneumatosaccus, is an elliptical ring of 0·5 mm. in breadth; its outer edge is densely beset with a series of marginal muciparous glands (*us*), and on the inside of this glandular corona runs the elliptical marginal canal (fig. 10, *cc*), into which open the numerous radial canals of the umbrella (*ce*).

Velarium (figs. 3–5, *uf*).—The vertical sail is a simple fold of the exumbrella, which arises in the longitudinal or sagittal axis of the elliptical disc, along the median line of the campanulate pneumatosaccus. Its form and size are very variable, since it is very contractile; if highly expanded, it appears nearly rectangular, with a median notch at the central top (fig. 3), and its vertical diameter is greater than the major axis of the horizontal disc; if strongly contracted it appears much smaller, and has the form of a shallow vertical elliptical disc (fig. 4). At other times it is more crescentic in form, or cordate with a deep constriction in the middle of the top.

The velarium is composed of an elastic support, or a thin vertical plate of jelly in its median plane (fig. 5), and a thin mantle-plate of the exumbrella, covering both sides of this fulcrum. This mantle-plate exhibits beyond the exodermal epithelium a double strong muscular layer, composed of two different strata, an outer thinner layer of transverse or horizontal muscles, and an inner thicker layer of longitudinal or vertical muscles; the bundles of the latter are parallel, of equal breadth, about forty or fifty on each side.

The parallel vertical bands of equal breadth ascending in the velarium to its top (twenty to thirty in the sagittal diameter) are simple vessels, which arise from the exumbrella of the campanulate pneumatosaccus. They are united at the free superior edge of the sail by a marginal sail canal. This runs along the whole free edge of the sail and opens at its base into the two sagittal canals of the exumbrella, which run to the two opposite poles of its major axis.

Subumbrella (fig. 2).—The inferior or basal face of the umbrella, beyond the series of marginal glands, consists from without, inwards, of the following parts:—(1) The inferior or subumbral side of the broad mantle border (*um*); (2) the elliptical corona of tentacles (*t*); (3) the corona of gonostyles (*gs*); and (4) the large central siphon (*so*).

Pneumatocyst (fig. 8, from above; fig. 9, from below; fig. 3, *pf*, in profile; fig. 5, *pf*, in vertical section).—The chitinous thin-walled float, filled with gas, is flatly campanulate with an elliptical quadrilobate outline. Its length (or principal axis) is 2 mm., its breadth or transverse axis 1·5 mm., and its height (or sagittal axis) also 1·5 mm. It is composed of an elliptical central chamber, an inner corona of eight radial chambers, and an outer corona of four to eight concentric elliptical ring-chambers. These latter are divided by two crossed centripetal furrows (a sagittal and a frontal notch) into four rounded lobes (figs. 8, 9). These are systematically arranged in pairs. The left anterior and right posterior lobes are smaller than the right anterior and left posterior.

Stigmata (fig. 8, *pe*).—The convex superior face of the pneumatocyst, which is covered by the exumbrella, exhibits only three stigmata. These lie in a straight line which crosses the major axis of the elliptical disc at a very small angle. The subcentral stigma (*po*) lies nearly in the top of the central chamber, and opens on the left side of the base of the sail; the second lies on the surface of the left anterior quadrant, and

the third on the right posterior quadrant of the pneumatocyst, each at the base of a radial chamber (fig. 8, *pe'* anterior, *pe''* posterior stigma).

Tracheæ (fig. 9, *pt*).—The concave inferior face of the pneumatocyst, which is in close contact with the superior convex face of the centradenia, gives off eight small bunches of tracheæ, each composed of two to four. These are simple undivided tubules, which arise from the periphery of the eight radial chambers of the pneumatocyst, and enter into the centradenia, where they end in its exodermal parenchyma.

Centradenia (figs. 3, 4, *uc*, in profile; fig. 5, *uc*, in vertical transverse section; figs. 6 and 7 in horizontal section, fig. 6 through the inferior, fig. 7 through the superior part).—The central gland, or the so-called "liver," has the form of a flat cone, strongly compressed from the two lateral sides, or of a thick vertical triangular lamella, which is somewhat sigmoidal, or slightly bent in an S-form. Its upper face is completely covered by the campanulate pneumatocyst; its lower face is in contact with the gastrobasal plate of the central siphon (fig. 5, *st*), and the surrounding corona of sexual siphons.

The glandular parenchyma of the centradenia is composed in the superior half more of entodermal canals, in the inferior half more of exodermal cells and cnidoblasts. The vascular reticulum of the superior face exhibits a star of eight radial main vessels; two of these, opposite in the longitudinal axis of the disc, are longer and stronger than the six others, which are disposed symmetrically on both sides of the former, three on the right, three on the left; the middle of these, or the frontal canal, is the shortest, whilst the two diagonal canals of each side are longer than the latter, shorter than the sagittal canals.[1] The numerous smaller vessels, which arise from these eight superior hepatic vessels, form an irregular network, which is rather dense in the superior half of the centradenia, loose in its inferior half; the axial part of the latter is chiefly composed of exoderm-cells.

The descending superficial canals of the centradenia pass over at its basal periphery into four different groups of canals:—(1) The numerous radial canals of the free mantle border (or pallial canals, fig. 10, *ce*); (2) the canals of the tentacles (fig. 5, *t*); (3) the canals of the gonostyles (*gs*); (4) the eight innermost canals which open into the base of the central siphon.

The pallial canals (fig. 10, *ce*), which run nearly horizontally from the periphery of the base of the liver to the edge of the mantle border, are very numerous, and so densely attached one to another, that their intervals are smaller than their lumen. Their distal ends, which open into the annular elliptical marginal canal (*cc*), are partly simple, partly forked; usually a simple and a forked vessel regularly alternating.

Central Siphon (fig. 2, *so*; fig. 3, *sa*; fig. 5, *sa*, in longitudinal section).—The large central polypite is a slender inverted cone, strongly compressed from both sides. Its elliptical basal plate is in contact with the basal face of the centradenia, and separated from it by the strong fulcrum of the gastrobasal plate (fig. 5, *st*). The periphery of this is

[1] Compare the figure of Bedot, 59, pl. ix. fig. 1.

pierced by eight openings which conduct into the eight primary radial vessels, arising from the original manubrium of the Medusa. The thick wall of the central siphon exhibits eight strong radial longitudinal folds, and its slender proboscis has eight lips around the terminal mouth (figs. 3, 5, *so*).

Gonostyles (figs. 2, 3, 5, *gs*).—The sexual siphons, sixteen in number, form an elliptical corona around the central siphon and separate it from the tentacular zone and the mantle-border. Their slender cylindrical basal part bears clusters of medusiform gonophores, whilst their dilated spindle-shaped distal part opens by a four-lobed mouth.

Tentacles (figs. 1–5, *t*).—The sixteen tentacles form an outer corona around the inner corona of gonostyles, and alternate regularly with the insertions of the latter. They are simple, cylindrical, very contractile, and beset with two opposite rows of cnidoblasts.

Genus 8. *Velella*,[1] Lamarck, 1816.

Velella, Lmk., Hist. nat. anim. sans vert., t. ii. p. 481.

Definition.—Velellidæ with an elliptical or slightly quadrangular (parallelogram-shaped) umbrella, and a vertical triangular sail, placed obliquely in a diagonal line of the ellipse. Margin of the umbrella not lobate. Pneumatocyst discoidal, of the same form as the surrounding umbrella, with a vertical chitinous crest supporting the sail. Sub-marginal corona of tentacles simple.

The genus *Velella* is, next to *Physalia*, the oldest and best known form of all Siphonophoræ, since it is generally distributed in all warmer seas, often very common, and in some countries used as food. Owing to its striking form and sailing movement it is well known to the fishermen. The Italian naturalists Ferrante Imperato (1599) and Columna (1616) mention it under the names *Vela* or *Velella*, Carburius (1757) and Dana (1776) under the names *Armenista* or *Armenistarion*. The first good description and figure were given in 1776 by the excellent Swedish naturalist Forskål;[2] he named the Mediterranean species *Holothuria spirans*. Afterwards Lamarck erected the genus *Velella* with three species (the Mediterranean *Velella limbosa*, the North Atlantic *Velella mutica*, and the South Atlantic *Velella scaphidia*). Eschscholtz[3] in his fundamental work described ten different species, and Lesson[4] as many as sixteen. But the greater part of these descriptions are worthless and quite insufficient, since they are founded only upon the different coloration and other characters of little value (for example, the different direction of the sail).

Two species of *Velella* only are hitherto completely known; the Mediterranean *Velella spirans*, very accurately described by Kölliker[5] and by Vogt,[6] and the North Atlantic *Velella mutica* by Alexander Agassiz.[7]

[1] *Velella* = Diminutive of *Vela*, sailing-boat.

[2] 11, Taf. xxvi. fig. K.

[3] 1, p. 168, Taf. xv.

[4] 3, p. 563.

[5] 4, p. 46, Taf. xi. figs. 9–15.

[6] 6, pls. i., ii.

[7] 57, pls. i.–vi.

The collection of the Challenger contains different species of *Velella*, collected in widely distant parts of the Atlantic and Pacific Oceans. The comparison of these species and of others which I have seen in many museums, has led me to the opinion that about a dozen different "good species," at least "geographical species," may be distinguished, and that these may be placed in two different genera, *Velella* (*sensu stricto*) and *Armenista*.[1] The genus *Velella* (*sensu stricto*), the type of which is the well-known *Velella spirans* of the Mediterranean, has an elliptical umbrella with an integral, not lobate margin, and a simple series of tentacles; it stands nearer to the ancestral form *Rataria*.

The second, more differentiated and larger genus, *Armenista*, has a more quadrangular or parallelogram-shaped umbrella, with a broad lobate margin, and a double or multiple series of tentacles. Perhaps even four genera may be distinguished when the numerous local varieties are better known.

The following species may be distinguished of the true *Velella* (*sensu stricto*):—

(1) *Velella spirans*, Eschscholtz, 1 (Mediterranean).

(2) *Velella caurina*, Eschscholtz, 1 (North Atlantic, observed by me in 1866 in the Canary Islands).

(3) *Velella scaphidia*, Peron (12), collected by the Challenger in the Guinea Current (Stations 346 to 352).

(4) *Velella oblonga*, Chamisso (21), collected by the Challenger off Volcano Islands, south of Japan (Stations 229 to 237).

(5) *Velella patella*, Brandt (25), collected by the Challenger in the Tropical Pacific (Stations 265 to 279).

Nearly related to the latter seem to be *Velella pacifica* of Eschscholtz and *Velella cyanea* of Lesson (South Pacific).

The other species of *Velella* described seem to belong to the following genus, *Armenista*.

Genus 9. *Armenista*,[2] n. gen.

Velaria, Hkl., System der Siphonophoren, 1888, p. 31.

Definition.—Velellidæ, with a quadrangular or parallelogram-shaped (sometimes slightly elliptical) umbrella, and a vertical triangular sail, placed obliquely in a diagonal line of the parallelogram. Margin of the umbrella lobate. Pneumatocyst discoidal, of the same form as the surrounding umbrella, with a vertical chitinous crest supporting the sail. Submarginal corona of tentacles double or multiple.

The genus *Armenista* (enumerated in my "System" as *Velaria*, a name already

[1] The name *Velaria* adopted in my System der Siphonophoren, 1888, p. 31, had previously been employed for a Sponge (Aplysinidæ).

[2] *Armenista* or *Armenistarium* (Carburius, 1757) is the Cephalonian term for sail = *Velella*.

employed for a Sponge) comprises those Velellidæ which differ from the true *Velella* by the broad lobate margin of the umbrella and by the double or multiple corona of tentacles; usually also by the quadrangular form of the umbrella, which in the former is more elliptical. Although a sharp boundary line between the true *Velella* (*s. str.*) and *Armenista* cannot be drawn, the differences of the extremely divergent forms are very striking; and when the intermediate forms are neglected, they represent two widely different genera. The elliptical umbrella with integral border of the mantle, and the simple corona of tentacles, brings the true *Velella* nearer to the ancestral *Rataria*. On the other hand, the larger *Armenista*, with the broad lobate border of the mantle of the quadrangular umbrella, and the double or multiple corona of tentacles, is a more recent and more differentiated form. To this genus belong probably the following species:—

(1) *Armenista sigmoides*, n. sp., from the Southern Tropical Atlantic, figured in Pl. XLIII., and taken by the Challenger at Station 346.
(2) *Armenista mutica*, Lamarck, from the North-western Atlantic, very good figures of which were published in 1883 by Alexander Agassiz (57).
(3) *Armenista antarctica*, Eschscholtz (1), and
(4) *Armenista indica*, Eschscholtz (1), from the Indian and Antarctic Oceans, and the Cape of Good Hope.
(5) *Armenista lata*, Chamisso (21), from the Northern Pacific.
(6) *Armenista lobata*, n. sp., from the Southern Pacific.

Armenista sigmoides, n. sp. (Pl. XLIII.).

Velella sigmoides, Hkl., 1881, MS.

Habitat.—Station 346, Tropical Atlantic; April 6, 1876; lat. 2° 42′ S., long. 14° 47′ W. Surface.

Umbrella (fig. 1, from above; fig. 2, from below; fig. 3, half lateral, half superior view).—The umbrella is nearly rectangular, with rounded edges, about once and a half or twice as long as broad; the longitudinal or sagittal diameter of the horizontal disc is in the largest specimens 80 to 90 mm., the transverse or frontal diameter 30 to 40 mm. This latter about equals the height of the triangular vertical crest or sail.

Exumbrella (fig. 1).—The superior or apical face of the umbrella is divided into the broad lobed mantle-border and the colourless pneumatic disc, both separated by a sharp line which is not parallel to the margin of the border. The vertical diagonal crest divides the exumbrella into two equal halves, an antero-dextral and a postero-sinistral. When we regard the disc in profile from the broad side (its major axis perpendicular to the axis of vision), the crest or sail runs from our proximal and left to our distal and right side; but seen from behind, from the smaller side (the major axis of the disc

parallel to the axis of vision), the vertical sail runs from our proximal and right to our distal and left side ("*Velella sinistra*," Chamisso).

Limbus Umbrellæ (fig. 1).—The broad soft border of the horizontal disc is widely prominent over the edge of the pneumatophore, and has four deep marginal incisions. Two opposite ones of these correspond to the diagonal axis of the sail (the macrodiagonal), and touch the two ends of its base; the two others correspond to the diagonal axis of the transverse or frontal groove (the brachydiagonal). The border of the mantle is divided by these four marginal incisions into four large lobes, which are disposed in pairs. The two lateral lobes (right and left) are nearly rectangular, and much smaller than the two crescentic sagittal lobes (anterior and posterior). Besides these four deep marginal incisions, which correspond to those of the edge of the pneumatophorous disc, the margin of the mantle-border often exhibits four smaller incisions alternating with the former; but these are not constant.

Subumbrella (fig. 2).—The inferior or basal face of the umbrella exhibits the smooth and lobed mantle-border to the same extent as the upper face. A deep elliptical incision, the tentacular or submarginal furrow (*ut*), separates it from the elliptical central area of the subumbrella. This area is bisected by the longitudinal axis of the spindle-shaped, long and narrow centradenia and the base of the central siphon. Numerous sexual siphons occupy the greatest part of that subumbrellar central area, whilst a double or triple corona of tentacles surrounds it.

Margin of the Sail.—The triangular vertical sail is composed of an inner chitinous crest arising from the pneumatocyst, and of a canaliferous plate of the exumbrella, covering the two sides of the former. This plate is prolonged over the free margin of the crest, and borders it as a soft contractile limb, which is the uppermost part of the original longitudinal mantle-fold.

Pneumatocyst (fig. 5, from above; fig. 6, from below; fig. 4, *p*, in vertical section).—The pneumatocyst is composed, as in all species of *Velella* and *Armenista*, of two different parts, the horizontal discoidal float filled with air, or the pneumatodisc, and the vertical triangular crest, which is the inner skeleton-plate of the soft sail, perpendicular to the disc, and placed in its greater diagonal.

The pneumatodisc, or the horizontal float, is sometimes elliptical or nearly rectangular in outline, at other times distinctly S-shaped. It is two and a half times as long as broad; in the largest specimen 50 to 60 mm. long, 18 to 21 mm. broad.

The four characteristic marginal incisions, which are described above of the mantle-border, are marked also in the periphery of the pneumatodisc (fig. 5); the two notches of the macrodiagonal touch the two ends of the base of the crest, whilst the two notches of the brachydiagonal approach the two ends of the frontal furrow. The four quadrants of the disc, which are separated by these four diagonal notches, are disposed in pairs opposite; the two lateral pairs form an oblique triangle with concave base, and their

surface occupies less than half the area of the two opposite sagittal pairs (posterior and anterior); these form a much broader oblique triangle with a prominent convex base.

The superior or apical face of the disc is slightly convex, the inferior concave; the convexity is much stronger in younger specimens (fig. 4) than in older (fig. 3).

The central chamber of the pneumatocyst (fig. 6, *ph*) exhibits nearly the same form as that figured in *Rataria cristata* (Pl. XLIV. figs. 8, 9). It is elliptical and distinctly octolobate. The deep frontal furrow proceeds near to the central chamber, so that the octoradial ring is bisected by it; its ventral half is composed of two anterior and two left chambers; its dorsal half of two posterior and two right chambers. Each of the eight radial chambers possesses a branched trachea, arising from the periphery of its basal side. The apical side of the octolobate ring, however, exhibits three stigmata only, placed near the macrodiagonal, one subcentral, an anterior upon the left ventro-lateral, and a posterior upon the right dorso-lateral chamber.

The concentric elliptical ring-chambers, which surround the octolobate central part of the float, are sixty to eighty in number in the largest specimens; those of the central and those of the peripheral part are half as broad as the intermediate chambers placed between them. Each elliptical ring-chamber is deeply bisected by the frontal furrow of the brachydiagonal. All elliptical ring-chambers communicate with one another by two opposite openings or pneumothyræ, which are placed one on each pole of the sagittal axis (fig. 5, *pg*).

The stigmata, or the external openings of the exumbrellar face of the float, are placed in one straight line, very near the base of the vertical crest, and this line bisects the latter at a very small angle (fig. 5, *pe*). There are in the largest specimen (besides the central stigmata) about thirty to forty stigmata opposite in pairs; these are situated, the half in the right ventral quadrant of the disc (to the right of the basis of the crest); the other half in the left dorsal quadrant (to the left of the basis of the crest).

The tracheæ, which arise from the inferior face of the disc, are not numerous. Besides the eight above-mentioned tracheæ, which usually arise from the octolobate ring (fig. 6, *pt*), there is in some specimens another corona of sixteen tracheæ, which arise from the sixth or ninth ring, or between these. But in other species there is no regular arrangement, a few scattered tracheæ arising here and there from one of the middle chamber-rings. In a few specimens I found an oblique double series of tracheæ arising along the frontal furrow, on both sides of it. The number, size, disposition, and branching of the tracheæ seem to be subject to many variations in this as well as in other species of the Velellidæ. Some tracheæ are very long (about equal to the diameter of the centradenia), and bear ten to twelve or more irregular and curved branches (fig. 10); others are much smaller, and bear only a few short branches. The majority of tracheæ run more horizontally beyond the pneumatocyst, and finish in the glandular tissue of the centradenia; but a few larger tracheæ pierce this latter, and enter partly into the exodermal wall of the central siphon, partly in that of the gonostyles, where they end in their proximal half.

The *Centradenia* (fig. 4, *uc*; fig. 7), or the so-called liver, is a lanceolate gland, the upper convex surface of which is flatly conical, and fills up the inferior concave face of the pneumatocyst (fig. 4, *pf*). Its lower flat horizontal face forms the roof of the central siphon, and is separated from its base by the gastrobasal plate, a thick structureless fulcrum (fig. 4, *st*). The periphery of this plate is pierced by sixteen radial main canals, which arise from the lanceolate base of the central siphon in two longitudinal rows, and run along the subumbrella towards its margin; they give off at their base sixteen ascending liver-canals, which run in the convex upper surface of the centradenia towards its conical apex, where they unite and form a central "liver-star." Very numerous lateral branches, which arise everywhere from these main canals, penetrate into the solid exodermal parenchyma of the centradenia, and form a very dense network by innumerable anastomoses. The vessels in the upper and outer (hepatic) part of the central gland are dark brown or black, thickly filled with pigment-granules (fig. 4, *uh*), except the uppermost; whilst the canals in the lower and inner (renal) part are white or colourless, and contain numerous small greenish guanin-crystals (fig. 4, *un*).

Central Siphon (fig. 2; fig. 4, *sa*; fig. 7, *sa*).—The large central polypite is inversely conical, sharply compressed from both sides, very contractile, and variable in form and size. Its lanceolate roof is nearly half as large as the adjacent basal face of the centradenia, and separated from it by the structureless fulcrum or the gastrobasal plate. Its muscular wall is very thick, and exhibits in some specimens outside eight or sixteen thick longitudinal ribs, which are prominent inside as deep grooves. The opening of the mouth has often eight triangular lips (fig. 4, *so*).

The periphery of the lanceolate base of the central siphon exhibits sixteen openings, which conduct into the sixteen radial main vessels of the subumbrella; two opposite of these gastral canals lie nearly in the sagittal axis of the subumbrella (one ventral and one dorsal), and these are much wider and longer than the fourteen other vessels which arise symmetrically from both sides (fig. 7).

Canal System (fig. 7).—The reticular system of anastomosing gastro-canals, which arise from the branches of the sixteen above-mentioned radial main canals, is in this, as in other large Velellidæ, very complicated. The following principal branches may be distinguished:—(1) The sixteen ascending superficial canals, which pass off from the former immediately at their origin, and end centripetally in the upper face of the centradenia; (2) very numerous canals which form a dense reticulum in the subumbrella; (3) numerous vessels which arise from the peripheral part of the centradenia, and enter into the gonostyles; (4) a smaller number of vessels, outside the latter, which open into the tentacles; (5) a corona of radial submarginal vessels which run in the peripheral part of the subumbrella, between the tentacular zone and the margin; these open into (6) a marginal ring-canal, which runs inside the series of marginal glands; (7) a coronal canal, or inner submarginal ring-vessel, runs in the furrow between

border and tentacular zone; from this arise (8) the numerous mantle-vessels of the exumbrella, which form a dense network in the latter, and from these arise (9) the mantle-vessels of the vertical crest, which form a dense network of different form on its two sides; four of these crest-canals are much stronger than the others, two opposite longer, which run along the free upper edge of the crest, and two opposite shorter, which bisect the triangular sides of the crest, and arise near the centre of the frontal groove; (10) a double series of elegant pinnate sail-canals, which arise from the large superior edge-canal of the crest, and run in the soft sail border towards its free margin; they are here united by a small outermost canal running in the free edge of the sail. The special form and reticulation of these numerous canals is about the same as figured by Alexander Agassiz[1] in *Velella* (*Armenista*) *mutica*.

Gonostyles (fig. 2; fig. 4, *gs*; fig. 8, *gs*).—The small sexual siphons, or "gonoblastidial polypites," are very numerous (many hundreds in the larger specimens) and densely crowded, occupying the entire broad gonostylar zone between the base of the central siphon and the corona of tentacles. Their upper or proximal half is cylindrical, and covered with bunches of medusiform gonophores (*g*); their lower or distal half is a contractile muscular stomach, beset with sixteen longitudinal rows of cnidonodes; its proboscis opens below by a very extensile mouth, and this is sometimes distinctly lobed (fig. 8, *so*). The special form and structure of the gonostyles is the same as figured by Alexander Agassiz[2] in *Velella* (*Armenista*) *mutica*.

Tentacles (figs. 1–4, *t*).—The corona of tentacles, placed in the elliptical groove between the outer edge of the gonostylar zone and the inner edge of the broad mantle-border; is composed of two or three rows of tentacles; those of the innermost row are the largest, and in the expanded state about as long as the transverse diameter of the umbrella. The tentacles of the outer row, alternating with the former, are only half as long; and when there is a third outermost row, these are very short. The form and structure of these cylindrical tentacles are the same as in other Velellidæ; they are beset on both sides with two lateral rows of sessile cnidocysts.[3]

Armenista sigmoides, as described above from the Tropical Atlantic (Station 346), is perhaps identical with a *Velella* of which I have obtained several specimens from Cape of Good Hope, collected by Dr. W. Bleeck. The short description and the figures which Eschscholtz (1) has given of *Velella indica* (also occurring at the Cape) are not sufficient to decide the question of the identity of these species. Further accurate examinations and comparative studies are required to enable a better distinction of the different species of Disconectæ.

[1] 57, pls. iv., v. [2] 57, pl. ii. [3] Compare Kölliker, 4; Vogt, 6; Huxley, 9; Agassiz, 57.

Subclass II. SIPHONANTHÆ.

Order II. CALYCONECTÆ, Haeckel, 1888.
(Pls. XXVII.–XLII.)

Diphyidæ, Eschscholtz, 1829, **1**, p. 122.
Calycophoridæ, Leuckart, 1854, **8**, p. 256.

Definition.—Siphonophoræ with one or more nectophores, without pneumatophore, and without palpons. Nectosome always without pneumatocyst, represented only by the nectophores. Siphosome either a single siphon (Monogastricæ) or a long tubular stem, bearing a series of equidistant siphons, separated by free internodes (Polygastricæ). Each siphon with a single tentacle bearing a series of tentilla or lateral branches; each tentillum with a cnidosac and a simple terminal filament.

The order Calyconectæ, hitherto usually called Calycophoridæ, comprises all Siphonophoræ without pneumatophore. No doubt this large group is very natural; it differs from all the other Siphonophoræ, not only in the complete absence of the important pneumatic apparatus, but also in a number of other peculiarities. The primary larva develops first a nectophore (in the others a pneumatophore). The siphons have always the same structure, and so also the single tentacle, which is attached to each siphon; it bears a naked cnidosac (without involucrum) of a constant structure. The long tubular stem of the polygastric Calyconectæ always bears a single row of ordinate cormidia, separated by naked free intervals. Each cormidium constantly bears a single siphon only, and a single tentacle. Palpons and palpacles never occur in the Calyconectæ.

History.—Eschscholtz, in his fundamental work,[1] divided the order Siphonophoræ into three natural families; the first of these, Diphyidæ, differs from the two other (Physophoridæ and Velellidæ) in the complete absence of any float filled with air. He distinguished six different genera; three of these (*Eudoxia*, *Ersæa*, *Aglaisma*) are monogastric ("with a single suctorial tube"); the three others (*Abyla*, *Cymba*, *Diphyes*) are polygastric ("with a long digestive tube bearing numerous suctorial tubes").

The oldest known of these six genera was *Diphyes*, founded by Cuvier in 1817,[2] upon an apparently double animal, or twin-zoophyte, of which Bory had given the first figure in 1804 under the name *Biphora bipartita* (**13**) (=*Diphyes dispar*, Chamisso).

Lesson adopted in 1843 (**3**, p. 424) the system of Eschscholtz, and divided the family Diphyidæ also into Monogastricæ and Polygastricæ. But he distinguished a greater number of genera and subgenera (partly constituted already in 1827 to 1833 by Quoy and Gaimard, **2** and **20**). Lesson collected all the scattered descriptions of Diphyidæ

[1] System der Acalephen, 1829, p. 122.
[2] Règne animal, édit. i., tome iv. p. 61.

published up to his time; but he could not distinguish the natural groups critically. Marked progress in our *anatomical* knowledge of the Calyconectæ was made by the excellent descriptions of different Diphyidæ which were published in the third period of our knowledge of Siphonophoræ (from 1853 to 1859, **4–10**) by Kölliker, Leuckart, Vogt, Gegenbaur, and Huxley. Two of these celebrated zoologists simultaneously and independently discovered, in the spring of the year 1853, that the monogastric Diphyidæ, or the so-called *Eudoxiæ*, were the isolated individual groups (or cormidia) of the polygastric Diphyidæ, detached from the common stem, and that the former were connected with the latter by a regular metagenesis. Gegenbaur observed in Messina the detached *Eudoxiæ* of *Abyla pentagona*.[1] The same observation was made at the same time in Nice by Leuckart, who further demonstrated that the monogastric *Eudoxia campanula* was the detached sexual zooid of his *Diphyes acuminata* (**5**, pp. 41, 69).

Leuckart in the next year (**8**, p. 256) replaced the name Diphyidæ by the more convenient term Calycophoridæ, and united in this family the true Diphyidæ (with two nectophores, *loc. cit.*, p. 257) and the Hippopodidæ (with a biserial nectosome, composed of four or more nectophores, *loc. cit.*, p. 298). The latter were formerly regarded as a separate family of Physophoridæ, though they possess no float filled by air.

Huxley in his great work (**9**, 1859) adopted the main group Calycophoridæ, and opposed it to all other Siphonophoræ or Physophoridæ. He gave the first exact description of many hitherto incompletely known forms, mainly Abylidæ. He was also the first to describe a very remarkable Calycophorid, which possesses only a single permanent nectophore, under the name *Sphæronectes köllikeri*, and rightly regarded it as the type of a new family, Sphæronectidæ.[2] Fifteen years later a very similar species of the same genus was described by Claus under the name *Monophyes gracilis* (**70**, pl. iv.). He observed its metagenesis and connection with that *Eudoxia* which Gegenbaur had described in 1854 as *Diplophysa inermis*.[3] The peculiar family represented by these Calycophoridæ, the Sphæronectidæ of Huxley, was called by Claus Monophyidæ, in opposition to Diphyidæ. Following the systematic manuals of recent years, I adopt the term Monophyidæ for all those polygastric Calyconectæ which possess only a single permanent nectophore, while I restrict the term Diphyidæ to those forms which have two permanent nectophores. A third family is formed by the Hippopodidæ,[4] which possess numerous (at least three or four) nectophores arranged *in* a biserial nectosome; they were afterwards named Polyphyidæ by Chun (**86**, p. 12).

The Polyphyidæ differ from the other Calycophoridæ in the lack of bracts. A new group, described in the sequel as Desmophyidæ, is intermediate between the Diphyidæ and Polyphyidæ, having in common with the former the possession of a bract on each eudoxome, with the latter a biserial nectosome, composed of numerous nectophores.

[1] **7**, p. 295; **4**, p. 78; **31**, p. 106.
[2] **9**, pp. 29, 50, pl. iii. fig. 4.
[3] **7**, Taf. xvi. fig. 3.
[4] Kölliker, **4**, p. 28.

In the numerous voyages which I have made during the past twenty-five years, in order to complete my System der Medusen (compare the Preface to that Monograph), I have found also many opportunities of examining a great number of Calyconectæ belonging to all the genera described in the following pages. The richest harvest was reaped during my residence in the Canary Islands (December 1866 to February 1867), where I was able to examine accurately a great number of new or imperfectly known Monophyidæ, Diphyidæ, and Polyphyidæ. I there traced the complete metagenesis of many typical genera and the ontogenetic connection of monogastric and polygastric Calyconectæ. Supported by this rich personal experience, I have in the following pages attempted to give a more correct definition of genera and a more natural arrangement than has hitherto been possible.

Nectophores.—The Calyconectæ differ from all other Siphonophoræ in the complete absence of any pneumatophore, so that the nectophores are the only organs of locomotion. The polygastric Calyconectæ bear on the top of the long tubular stem either one or two large nectophores (Monophyidæ and Diphyidæ), rarely a biserial nectosome, which is composed of two opposite rows of nectophores, four to six or more (Desmophyidæ and Polyphyidæ). The locomotion of the monogastric Calyconectæ is effected usually by the subumbrella of the gonophores (Eudoxidæ); but in the Ersæidæ the first-formed gonophore loses its sexual functions, and acts as a "special nectophore."

The larva of the Calyconectæ, which develops from the fertilised egg, and which we call *Calyconula* (Pl. XXVII. figs. 8–11), is a bilateral medusoid person, the manubrium of which lies outside the campanulate umbrella, apparently protruded through a ventral fissure of the latter.[1] The "primary nectophore" of this Calyconula often (perhaps always) becomes detached, and replaced by a secondary nectophore, which is often heteromorphous.

The number, arrangement, and form of the nectophores in the different Calyconectæ are very variable, and serve mainly for the distinction of genera. Regarding the general form of the nectophores, we may distinguish two different main groups, Sphæronectariæ and Cymbonectariæ; the umbrella of the former consists of a very soft jelly, and is subspherical, mitriform or reniform, always devoid of distinct edges, with rounded surface. The umbrella of the latter, on the contrary, has always a definite geometrical form, and is polyhedral, either pyramidal or prismatic, with polygonal faces and sharp, often denticulate, edges; its jelly-substance is rather hard and firm, often cartilaginous.

Nectosac and its Canals.—The original form of the muscular subumbrella in the Calyconectæ is hemispherical, but usually in correlation with the fundamental form of the nectophores (primary as well as secondary umbrella) it is more or less bilateral, and at the same time quadriradial; the latter structure (inherited from the ancestral Anthomedusæ) is indicated by the constant four radial-canals of the subumbrella;

[1] 7, Taf. xvi. figs. 12–21; 85, Taf. vi., vii.; 86, Taf. xvii. figs. 6, 7.

and these are always so differentiated, that two opposite lateral vessels (right and left) are symmetrical, different from the two sagittal vessels (shorter ventral and longer dorsal canal). The sagittal plane, which divides the body of the nectophore into right and left halves, is therefore precisely marked by the two latter opposite canals. Usually both halves are symmetrical, but sometimes more or less asymmetrical. The velum which surrounds the ostium of the muscular nectosac is usually rather broad and strong. The four radial canals are connected above the insertion of the velum by a constant circular canal.

Pallial Canals.—Besides the four constant radial canals, there are in many Calyconectæ one or two pallial canals or nutritive vessels of the jelly-substance of the nectophore. An apical pallial canal runs in many Diphyopsidæ from the top of the nectosac to the apex of the umbrella. *Praya* and others have two pallial canals at the ventral side, an ascending and a descending.

Number and Arrangement of the Nectophores.—The number of the swimming-bells, and their arrangement on the top of the stem, are employed by modern authors to divide this order into three families:—Monophyidæ, Diphyidæ, and Polyphyidæ. The Monophyidæ (or Sphæronectidæ) possess a single large nectophore on the top of the stem; this is smooth and without distinct edges in the true Sphæronectidæ, sharp-edged or pyramidal in the Cymbonectidæ.

The Diphyidæ, comprising the great majority of genera and species (among the living Calyconectæ), have always two large nectophores on the top of the stem. These are opposite, of nearly equal size and similar form, with rounded exumbrella, in the subfamily Prayidæ. They are also of nearly equal size and similar form in the subfamily Diphyopsidæ; but in this group the exumbrella is sharp-edged, pyramidal, and the two nectophores are not opposed, but one placed behind or below the other. The remarkable subfamily Abylidæ is distinguished by two nectophores of very unequal size and dissimilar form; the first or anterior being much smaller than the second or posterior. The form of the two very different nectophores becomes in this group extraordinarily strange and complicated.

The Polyphyidæ (or Hippopodidæ) and the closely allied Desmophyidæ are distinguished from the other Calyconectæ by the possession of a biserial nectosome, similar to that of most Physonectæ. There are here at least four to six nectophores (sometimes ten to twelve or more), arranged in two opposite series. They have here no definite edges, and are mitriform or reniform in *Desmophyes*, *Hippopodius*, and *Polyphyes*; whereas they are angular (pentagonal), prismatic, or pyramidal in *Vogtia*.

It may be that all the Calyconectæ with rounded nectophores represent a natural suborder of this order (Sphæronectariæ), and all the others (with edged or pyramidal nectophores) another suborder (Cymbonectariæ). The first suborder (Sphæronectariæ) comprises the Sphæronectidæ, Prayidæ, Desmophyidæ, and Hippopodidæ. The second

suborder (Cymbonectariæ) would include the Cymbonectidæ, Diphyopsidæ, Abylidæ, and Vogtidæ.

Hydrœcium or Infundibulum (funnel cavity, house-room, Gehäuskammer, Trichterhöhle, Stammbehälter).—All polygastric Calyconectæ possess a protective cavity, into which the contracted siphosome may retire. This hydrœcium (or infundibular cavity) is always an external space, filled with sea-water and invested by the exoderm. In the Monophyidæ it is originally an open groove or fossula on the ventral side of the single nectophore (*Monophyes, Cymbonectes*, Pl. XXVII.). This open groove, or the "hydrœcial sulcus," becomes a closed cylindrical or conical canal, by concrescence of the two opposite margins, or by deeper invagination of the exodermal fossula, in another part of the Monophyidæ (*Sphæronectes, Muggiæa, Cymba*, Pl. XLI.). The singular genus *Mitrophyes* (Pl. XXVIII.) has no hydrœcium, but it is replaced here by a pouch-like space between the permanent secondary nectophore and a mitre-shaped or scutiform bract, which is the remnant of the reduced primary nectophore.

The hydrœcium of the Diphyidæ exhibits various degrees of development. In the Prayidæ it is an incomplete canal, formed by two opposite ventral grooves of the two nectophores, fitting one into another. *Diphyes, Diphyopsis*, and the Abylidæ possess a conical infundibular cavity at the ventral side of their first or apical nectophore, and this continues into an incomplete hydrœcial canal, formed by a longitudinal groove at the ventral side of the second or basal nectophore. The two margins of this groove are often partly united by concrescence, so as to form a shorter or longer canal. In other cases the two opposite margins of the hydrœcial groove are developed in the form of two broad dentate plates (right and left) which overlap one another. The genus *Galeolaria* has no hydrœcium, the siphosome hanging freely down between the distal end of the first and the proximal end of the second nectophore.

The hydrœcium of the Desmophyidæ and Polyphyidæ is an infundibular cavity between the two opposite rows of nectophores, almost as in the Prayidæ.

Somatocyst or Acrocyst (top-cavity of the stem, coryphal cavity; Saftsack, Saftbehälter, *cs*).—The single nectophore of the Monophyidæ, and the first or proximal nectophore of the Diphyidæ, contains a remarkable cavity, the acrocyst or somatocyst, at the ventral side of its nectosac and at the top of its hydrœcium. This is the uppermost part of the common trunk included in the jelly-substance of the first nectophore; it may be compared to the apical canal or peduncular canal of the ancestral Medusa, which was connected by it with its hydropolyp-parent. The somatocyst is usually spindle-shaped or ovate, at other times subspherical or cylindrical; its upper or apical end is blind, whilst its lower or basal end passes directly into the small apical central cavity, from which arises the central canal of the stem and the pedicular canal of the nectosac.

The narrow cavity of the somatocyst, or the acrocyst-canal, is invested by very large entoderm cells, usually vacuolated and polyhedral owing to mutual compression. Its

uppermost part usually includes a smaller or larger oil globule, the oleocyst (*co*). The physiological function of the somatocyst may be hydrostatic (as a float) and nutritive (as an accumulation of nutritive, strongly refracting albuminous globules). Its morphological nature is explained by the medusome-theory which compares it with the apical canal or original peduncular canal of a Medusa-person.

Trunk or Cœnosarc.—The common stem in all polygastric Calyconectæ is a long cylindrical and highly contractile tube, very long and thin in the expanded state, short and thick in the contracted state, when it is retracted into the hydrœcium. The cormidia are always ordinate, arranged in a single series on the ventral side of the articulated stem; they are separated by free naked internodes of equal length. Very rarely (in *Polyphyes*) the cormidia begin to be scattered. The number of the cormidia is in the smaller cormi ten to twenty (rarely less), usually forty to eighty or more, sometimes several hundreds. In the largest species (mainly of *Praya*) the expanded stem attains a length of more than a metre. The structure of the stem-wall is that usually found in the Siphonanthæ; the tubular fulcrum (or structureless supporting plate) is invested on its inner side by a thin layer of entodermal circular muscles, on the outside by a strong layer of exodermal longitudinal muscles; these are arranged, as usual, in parallel bundles along the lamellar radial folds of the fulcrum.

Cormidia.—The aggregation of different medusoid persons, by which the cormus of the Calyconectæ is formed, follows certain simple and regular laws, but is different in the two kinds of cormidia, which we distinguish as *Eudoxomes* and *Ersæomes*. The cormidia of the great majority of Calyconectæ are *Eudoxomes*, or in the free independent state "Eudoxiæ" or "Diphyozooids"; each Eudoxome is a twin-group, composed of two medusoid persons, a fertile and a sterile medusome. The sterile medusome is composed of a bract, a siphon, and a tentacle. The fertile medusome is represented originally by a single medusiform gonophore, but afterwards this is often replaced by a cluster of several gonophores.

The *Ersæomes* (or the monogastric generation of *Lilyopsis* and *Diphyopsis*) differ from the Eudoxomes in the fact that the primary gonophore loses its sexual manubrium, and is converted into a so-called "special nectophore"; its sexual function is replaced by a secondary gonophore. The Ersæome, therefore, is composed of three medusoidal persons, a sterile medusome (bract, siphon, and tentacle), a sterile nectophore, and a fertile gonophore. Afterwards the latter is often replaced by a cluster of several accessory gonophores.

The sessile gonophores of the Eudoxomes and Ersæomes attain sexual maturity, whilst attached to the trunk, in *Mitrophyes* and *Cymbonectes* among the Monophyidæ, *Praya* and *Galeolaria* among the Diphyidæ, probably in all Desmophyidæ and Polyphyidæ. This is not the case in the majority of Monophyidæ and Diphyidæ. Here the cormidia become detached from the common stem before reaching maturity, and swim freely

about under the individual form of self-subsistent monogastric Calyconectæ (*Eudoxia* and *Ersæa*, Families IV. and V.).

Bracteæ or Hydrophyllia (Protective persons or shields, Protecta, Phyllozooids—"Deckstücke, Deckschuppen" of German authors).—Three families of polygastric Calyconectæ, the Monophyidæ, Diphyidæ, and Desmophyidæ, possess constantly a single bract on each cormidium; it is wanting only in the fourth family, Polyphyidæ, where it has been lost by reduction. The single bract of each cormidium is the reduced umbrella of the Medusa-person, the manubrium of which is the single siphon of the former. This is very obvious in *Praya*, *Calpe*, and some other genera, where the bract still possesses four radial canals. Usually some of these canals are lost, or they have disappeared altogether.

Each bract has a convex exumbrella and a concave subumbrella, both separated by the basal margin of the umbrella. The form of the bract is very various, and characteristic of the single genera of monogastric Calyconectæ; usually it corresponds more or less to the form of the first nectophore. It is hemispherical, mitriform or subspherical, with a smooth exumbrella, in the polygastric Sphæronectidæ, Prayidæ, and Desmophyidæ. The bract is pyramidal, spathiform or conical, with sharply edged exumbrella, a ventral fissure, and a pointed apex in the Cymbonectidæ and Diphyopsidæ; it is prismatic with polygonal faces and sharp edges in the Abylidæ.

The bracteal cavity corresponds with the subumbrellar cavity of the ancestral Medusa, but has lost its important muscle-plate; it embraces the siphon, the single tentacle, and the gonophore; the last is placed at the ventral side of the siphon, the tentacle at its dorsal side. The nutritive canals of all the organs unite in the top or the centre of the bracteal cavity, where it communicates also with the central canal of the common stem by a short bracteal canal. From the same point arises also the phyllocyst.

Phyllocyst.—The apical cavity or coryphal cavity of the bract, which we call shortly "phyllocyst," corresponds to the acrocyst or somatocyst of the nectophore. Its form and the number and disposition of its apophyses are often very characteristic of the individual genera of Calyconectæ. Usually the phyllocyst is an ovate or spindle-shaped sacculus of the same structure as the acrocyst, filled with large polyhedral vacuolated cells, and often containing also an oleophore or an apical oil-globule. It arises usually more or less vertically from the top of the subumbrellar cavity, and projects into the thick jelly-substance of the bract. From its base arise sometimes four radial canals, which correspond to the four original subumbrellar radial canals of the nectophores, in *Praya* (Pl. XXXII. figs. 8, 9) and in *Calpe* (Pl. XL. figs. 14–18). These are so arranged that two paired canals lie on both sides of the bilateral bract (right and left), and two odd in the sagittal plane (dorsal and ventral). The majority of the Calyconectæ do not now possess the four original canals. *Cymba* and *Abyla* have only two lateral canals; *Bassia* a single basal canal, arising from the base of the phyllocyst; often they are entirely lost (*Diphyes*, *Monophyes*, &c.).

The genus *Mitrophyes* among the Monophyidæ (Pl. XXVIII.) differs from all other Calyconectæ in the remarkable peculiarity that the convex exumbrella of the single nectophore is covered by a large concave scutiform bract, and that the contracted siphosome is retracted into the space between the former and the latter. We may assume that here the primary nectophore of the larva, instead of being lost, is converted into a permanent bract.

Siphons or Polypites.—Each cormidium of the Calyconectæ possesses constantly only a single siphon, and this is the manubrium of the medusome, the modified umbrella of which is the bract. A single long tentacle is always attached to the base of the siphon, between its dorsal side and the concave bract-wall. When the cormidium is detached from the common stem, and represents an independent free Eudoxia or Ersæa, it is therefore called a "Monogastric Calyconecta."

The siphons of all Calyconectæ are of similar form, of moderate or small size, very contractile. The four segments or parts of each siphon are usually very distinct, viz., (1) a short peduncle to which is attached the tentacle; (2) a hemispherical or subspherical basigaster with a thick wall; (3) an ovate or ellipsoidal stomach; and (4) a very mobile proboscis with the terminal mouth. (Compare Pl. XXVII. fig. 8, &c.)

The pedicle of the siphon (*sp*) is usually very short, sometimes rudimentary, and connects as a narrow cylindrical canal the gastral cavity of the former with the common alimentary cavity of the stem. The tentacle arises from it sometimes more proximally, at other times more distally; sometimes even more from the following part.

The basigaster (*sb*), or the bulbous basal portion of the siphon, is usually subspherical or ellipsoidal, and distinguished by a much-thickened exodermal wall; this is filled with innumerable densely crowded nematocysts. Its outer and inner surfaces bear a vibratile epithelium. Its small ovate cavity is separated from the stomach by a pyloric valve, which can be closed completely.

The stomach (*sm*) is ovate or ellipsoidal, with a thin, non-ciliated exoderm; its entoderm, however, is very thick, glandular, and often exhibits eight or sixteen hepatic stripes (often of a yellow, red, or orange colour), sometimes instead of these hepatic villi; some of the entoderm cells are usually vacuolate.

The proboscis (*sr*) or the distal portion of the siphon, is very contractile and extensile, with a strong muscular plate; its free distal end opens through the mouth. The very mobile mouth may be expanded in the form of a suctorial disc, circular, or polygonal; it is often octolobate (more rarely with four, twelve, or sixteen lobes).

Tentacles.—The capturing filaments or tentacles of the Calyconectæ exhibit in all members of this order essentially the same structure, and are very uniform, compared with the manifold and richly varied forms which we find in the similar tentacles of the following order—Physonectæ. In all Calyconectæ, without exception, each siphon bears at its base a single, tubular, very long and extensile tentacle, which is beset with a single

series of lateral branches or tentilla. Each tentillum is a thinner cylindrical tubule, and is constantly composed of three different parts—(1) a thin pedicle or proximal portion (*tp*), (2) an inflated cnidosac as a dilated middle part (*tk*), and (3) a thin distal portion, the terminal filament (*tf*). The closed distal end of the latter is sometimes vesicular; so also the distal end of the pedicle is sometimes club-shaped. The structure of the thin cylindrical pedicle and of the long terminal filament is simple and always the same, whilst the cnidosac, placed between them, exhibits a complicated, and more or less varied structure (compare Pl. XXVII. fig. 7; Pl. XXVIII. fig. 8; Pl. XXXII. figs. 12–14; Pl. XXXIV. fig. 18; Pl. XXXVI. fig. 26; Pl. XXXVIII. fig. 16; Pl. XL. figs. 19, 20).

The cnidosac (or sacculus) of all Calyconectæ is originally nothing more than an inflated dilatation of the middle part of the simple cylindrical tubular tentillum. This dilatation seems to be produced by the stronger development of larger cnidocysts on one side of its middle part. This side, which contains the so-called "cnido-battery," is the convex dorsal side of the cnidosac, whilst the opposite ventral side is usually more or less concave; it contains two parallel elastic bands, which seem to form together a noose at the distal end of the cnidosac, the so-called "cnido-band or angle-band." The whole cnidosac, therefore, has a bilateral form, usually more or less ovate, pyriform, or kidney-shaped. In most Calyconectæ it is more or less compressed from both sides, so that the sagittal axis is larger than the frontal, but smaller than the principal axis.

The differentiated cnidocysts, or thread-cells, which are crowded in great numbers in the "cnido-battery" at the convex dorsal side of the cnidosac, occur generally (probably in all Calyconectæ) in three different forms—(1) very numerous, small, and palisade-shaped (paliformes); (2) few, large, and sabre-shaped (ensiformes); (3) small and pear-shaped, in a distal group (pyriformes). These are so arranged that several parallel rows of paliform or medial cnidocysts occupy the whole convex dorsal side of the cnidosac (*km*), two bilateral groups of a few large ensiform cnidocysts are placed at each side of its proximal basal part (*kg*), and an odd distal group of small pyriform cnidocysts (*kp*) lies at its distal end, at the base of the terminal filament (*tf*).

The small palisade-shaped or medial thread-cells (*Cnidocystæ paliformis, km*) are always very numerous, usually some hundreds in number, and comprise far the greatest part of the crescentic cnido-battery, occupying the dorsal half of the sacculus. They are arranged so regularly that they form together a certain number (usually four, six, or eight) of parallel longitudinal columns, each composed of a single series of numerous (twenty to fifty, or more) cnidocysts. All the latter are cylindrical or spindle-shaped bacilli, of similar form and equal size, three to six times as long as broad, sometimes straight, at other times slightly curved. Their axis is perpendicular to that of the sacculus. The convex dorsal surface of the sacculus, therefore, appears elegantly panelled or facetted, the outer or abaxial ends of the paliform cnidocysts forming regular transverse rows (crossing the longitudinal rows).

The large sabre-shaped or lateral thread-cells (*Cnidocystæ ensiformes, kg*) form constantly two small lateral groups in the basal or proximal part of the sacculus, covering both the right and left sides of the base of the cnido-battery. Their number and form are often characteristic of the individual species of Calyconectæ. Thus, for example, *Mitrophyes peltifera* (Pl. XXVIII. fig. 8) has only two, *Cymbonectes huxleyi* (Pl. XXVII. fig. 7) three, *Diphyopsis compressa* (Pl. XXXIV. fig. 18) six large lateral thread-cells on each side of the base of the sac; their number is larger in the Abylidæ (usually eight to twelve), and especially in the Prayidæ (sixteen to twenty, or more, on each side). Their form is usually slender, spindle-shaped or sabre-shaped, four to eight times as long as broad, straight, sometimes slightly curved; but sometimes they are more rounded, ovate (as in the smallest Calyconectæ). They are always placed in a single longitudinal row, parallel to one another, and also (more or less) to the axis of the sacculus. Usually the axis of the ensiform cnidocysts is so directed obliquely that the dorsal end is more proximal and medial, the ventral end more distal and lateral.

The small pear-shaped or distal thread-cells (*Cnidocystæ pyriformes, kp*) always form an odd group at the distal end of the cnidosac and touch the base of the terminal filament (*tf*). Their number is very variable, usually between twenty and sixty. The group formed by these pyriform cnidocysts has usually the form of a rounded cap, covering the distal end of the cnido-battery, and is evidently sensitive to a remarkable degree, since long cnidocils arise from these thread-cells. Sometimes the group is trilobate, with an odd middle and two lateral lobes; and in some species it is even divided into three separate parts, an odd medial group being separated from two paired lateral groups, as in *Praya* (Pl. XXXII. figs. 12–14) and in *Bassia* (Pl. XXXVIII. fig. 16).

The elastic angle-band, composed of two very long linear and parallel ribbands, is closely coiled up spirally in the thin-walled ventral pouch of the closed cnidosac. But when this becomes opened (by rupture of the thin ventral wall), then the angle-band is expanded to a great length, often folded in a zigzag. Its proximal end remains in connection with the pedicle (*tp*), its distal end with the terminal filament (*tf*). The cnido-battery becomes hung out, and is freely prominent, and its distal end only remaining in connection with the proximal part of the terminal filament and its junction with the elastic angle-band (Pl. XL. fig. 20).

Gonophores.—The sexual persons of the Calyconectæ are always quadriradial Medusæ, with a well-developed umbrella and a manubrium, in the thickened wall of which the sexual cells are produced from the exoderm. The cavity of the manubrium has, however, no mouth opening, and the margin of the umbrella bears no tentacles. Originally each cormidium possesses only one gonophore, and in many Calyconectæ never more than a single sexual medusome is attached to the siphon. But when this gonophore is mature, it usually detaches itself from the cormidium (Eudoxia) and may be replaced by a secondary or vicarious gonophore. In many species (mainly of Abylidæ)

two or three gonophores are developed simultaneously in a single cormidium, and in some genera (*Lilyopsis*, *Desmophyes*) a bunch of numerous clustered gonophores; then usually their umbrella is more or less rudimentary, whilst still a "special nectophore" is developed as a swimming organ.

Each single gonophore is always gonochoristic, either male or female. Those cormidia, which bear two or more gonophores, are usually also gonochoristic (diclinic); but in some cases they are hermaphrodite, one of the gonophores being female, the other male (monoclinic cormidia). The corms of the polygastric Calyconectæ are usually monœcious and bear cormidia of both sexes, sometimes regularly alternating (as in *Cymbonectes*, Pl. XXVII., and *Desmophyes*, Pl. XXX.). At other times the distal (older) cormidia are males, and the proximal (younger) cormidia females. A few genera of polygastric Calyconectæ are dicœcious, each cormus bearing only gonophores of one sex, either male or female (*Mitrophyes*, *Galeolaria*). But the question of the relation of these different forms of sexual differentiation requires a further examination.

Umbrella of the Gonophores.—The calyx or umbrella of the sexual persons has in all Calyconectæ the same structure as in a common simple quadriradial Hydromedusa. Its form is very rarely quite regular, hemispherical (as in *Diplophysa* and some Polyphyidæ); usually it is more or less bilaterally symmetrical, in adaptation to its place inside the bracteal cavity, at the ventral side of the siphon; sometimes it is strongly asymmetrical, as in *Amphiroa* (Pl. XXXVI. figs. 12–25); here two gonophores are developed simultaneously on each side of the siphon (right and left); each corresponding to an antimere, so that the two together form a symmetrical pair.

The Exumbrella of the Gonophores corresponds in its general form to a certain degree with that of the nectophores. It is therefore evenly convex and smooth, without prominent edges, in most Sphæronectariæ (Sphæronectidæ, Prayidæ, Hippopodidæ). On the other side, it is quadrangular, pyramidal, or prismatic, in most Cymbonectariæ (Cymbonectidæ, Diphyopsidæ, Abylidæ). Usually in the latter the four edges of the exumbrella are sharp and prominent, often elegantly denticulate, and wing-like dilated in the distal part; their distal ends are often prominent as four strong triangular teeth over the basal ostium of the umbrella. Often two paired dorsal edges and their terminal teeth are much more developed than the opposite two ventral edges. More rarely a single wing is stronger than the three others, or even five wings may be developed instead of four (compare *Amphiroa*, Pl. XXXVI.). The uppermost part of the exumbrella is usually prolonged into an apical horn, or a hook-shaped apophysis, which serves for its insertion into the bracteal cavity.

The Subumbrella of the Gonophores has always a well-developed layer of ring-muscles (*w*), and, on its distal prolongation, a circular velum (*v*) which closes the peripheral part of the opening of the subumbrellar cavity. Four radial canals (*cr*) always run in the subumbrella from its apex, diverging to its basal ostium, where they are united, above

the insertion of the velum, by a ring-canal (*cc*). From their apical junction arises a peduncular canal (*cp*) which runs through the pedicle of the gonophore (or the apical horn) to its insertion into the bracteal cavity and opens here into the phyllocyst.

Gonads.—The gonad, or sexual gland of each gonophore, is represented by the manubrium, which depends from the apex of the subumbrella into its cavity. In the mature state it usually fills about the apical half of that cavity, but in many cases the entire cavity, and sometimes by further growth it becomes much larger than the latter, and is widely prominent through its distal opening (for example, in *Lilyopsis*, *Desmophyes*, *Vogtia*, Pl. XXX.). Each gonad is a simple, cylindrical, ovate, or spindle-shaped sac, and contains a central cavity, which is closed at the distal end, whilst it opens at the proximal end into the peduncular canal. The thick wall of the cavity consists of three different layers, outside a covering exodermal epithelium, and inside a vibratile entodermal epithelium, which includes the cavity (spadix); between these is a layer of sexual cells, which are originally derived from the exoderm. They produce a number of large ovules (usually between twenty and forty) in the female, and innumerable small zoosperms in the male gonophores. The ovaria or female gonads are usually somewhat rounded, ovate or club-shaped, colourless (Pl. XXVIII. fig. 4; Pl. XXXIV. figs. 13, 14, &c.). The spermaria or male gonads are rather elongated, cylindrical, or fusiform, often vividly coloured (yellow, orange, red) (Pl. XXVIII. fig. 6; Pl. XXXIV. figs. 11, 12, &c.).

Ontogeny.—The development of the Calyconectæ from the fertilised egg has hitherto been very little known. The first observations were made in the spring of 1853 by Gegenbaur in Messina.[1] He observed the segmentation of the egg of *Diphyes sieboldii*, and the development from it of a larva, which is a peculiarly modified medusome, composed of a simple nectophore and a cylindrical sac-shaped larval body, which is attached externally to the ventral side of the nectophore. In my opinion the mouthless larval body is the original siphon, protruded through a ventral fissure of the nectophore. From its base the primary tentacle arises afterwards. I call this larva *Calyconula*.

A similar Calyconula is developed from the egg of *Galeolaria aurantiaca* (= *Epibulia aurantiaca*), which Metschnikoff described in 1874.[2] The Calyconula of *Hippopodius gleba*, described by the same author,[3] exhibits still more distinctly the dislocation of the siphon, the axis of which is perpendicular to that of its nectophore, in the subumbrellar cavity of which it was originally placed. The remnant of the ventral fissure of the bilateral umbrella is yet partly visible.

The Calyconula of a Monophyid (*Muggiæa kochii*), and its development from the egg as well as its metamorphosis, were described in 1882 by Chun.[4] This larva developed

[1] 7, p. 332, Taf. xvi. figs. 12–21.
[2] 85, p. 39, Taf. vi., vii.
[3] *Loc. cit.*, p. 46, Taf. xi. figs. 5–8.
[4] 86, p. 9, Taf. xvii. figs. 6, 7.

directly into *Cucubalus eschscholtzii* (= *Eudoxia eschscholtzii*), the monogastric generation of *Muggiæa kochii*.

Scarcely different from this is the ontogeny of another Monophyid (*Cymbonectes huxleyi* (Pl. XXVII. figs. 8–11), which I observed in December 1881 during my residence at Belligemma, in Ceylon. The Calyconula here presents distinctly the character of a bilateral Medusa, through the ventral fissure of which the siphon was protruded; its distal end opens through the mouth rather early. Its similarity to the young Eudoxia of the same species is interesting.

Metamorphosis.—All Calyconectæ seem to undergo a metamorphosis, since the gastrula, developed from the fertilised egg, develops into a larva differing more or less considerably from the adult state. But the metamorphosis of the larva is very little known, and has been observed in a few species only. Chun, who has observed accurately the metamorphosis of some Monophyidæ and Diphyidæ (86–88), holds the opinion that the primary umbrella of the medusiform larva is always lost and replaced by a heteromorphous secondary umbrella. More extended researches are required to prove whether this supposition is generally true.

Metagenesis.—The majority of Calyconectæ are subject to a regular metagenesis, two different generations alternating regularly, as in the majority of the Anthomedusæ. The first generation is a monogastric and sexually developed cormidium—Eudoxia or Ersæa. From its fertilised egg arises a larva, which is transformed by metamorphosis into the second generation— Monophyid or Diphyid. Its body is a polygastric corm, the tubular stem of which produces numerous cormidia by budding asexually. Each cormidium, provided with a single siphon, afterwards becomes detached from the stem, and maturing as a Eudoxid or Ersæid returns to the first generation.

Hypogenesis.—The minority of Calyconectæ develop by hypogenesis (not by metagenesis); the cormidia arrive at full sexual maturity whilst sessile on the common stem, and are not detached from the latter. There is here, therefore, no free and independent monogastric generation; neither free Eudoxidæ nor Ersæidæ arise. The ontogeny of these polygastric corms is in a strict sense a strophogenesis.[1]

The Calyconectæ which are developed by hypogenesis are the following:—All the Polyphyidæ and Desmophyidæ, some Diphyidæ (*Galeolaria, Lilyopsis*, and *Praya ?*) and several Monophyidæ (*Monophyes* partly ?, *Mitrophyes*, and *Cymbonectes*). All the other Calyconectæ develop by metagenesis. There seem to be, however, some intermediate forms of ontogeny, in some species the male gonophores becoming detached, whilst the females remain attached to the stem, or inversely. These relations, as well as the whole ontogeny of the Calyconectæ, require further accurate examination.

[1] On the difference between metagenesis and strophogenesis, see my Generelle Morphologie, 1866, Bd. ii. pp. 104–109, and on Hypogenesis, *op. cit.*, p. 99.

Metagenesis Calyconectarum.

Synopsis of the alternation of generations in the genera of monogastric and polygastric Calyconectæ (compare the descriptions of the individual genera and species in this Report).

I. Monogastric Generation.	II. Polygastric Generation.
Diplophysa inermis, Ggbr., Mediterranean.	*Sphæronectes gracilis*, Hkl., Mediterranean.
Diplophysa köllikeri, Hkl., Tropical Pacific, Indian Ocean.	*Sphæronectes köllikeri*, Huxley, Tropical Pacific, Indian Ocean.
? *Eudoxella didyma*, Hkl., Atlantic.	? *Praya cymbiformis*, Leuck., Atlantic.
? *Eudoxella galea*, Hkl., North Atlantic.	? *Praya galea*, Hkl., North Atlantic.
Cucubalus eschscholtzii, Huxley, Mediterranean.	*Muggiæa kochii*, Chun, Mediterranean.
Cucubalus pyramidalis, Will, North Atlantic.	*Muggiæa pyramidalis*, Busch, North Atlantic.
? *Cucubalus cordiformis*, Quoy, Tropical Pacific.	? *Muggiæa chamissonis*, Hkl., Tropical Pacific.
Cuboides vitreus, Quoy, Mediterranean.	*Cymba enneagonum*, Esch., Mediterranean.
Cuboides crystallus, Hkl., North Atlantic.	*Cymba crystallus*, Hkl., North Atlantic.
Cuboides nacella, Hkl., Indian Ocean.	*Cymba nacella*, Lesson, Indian Ocean.
Cuboides vogtii, Hkl., Tropical Pacific.	*Cymba vogtii*, Hkl., Tropical Pacific.
Cucullus campanula, Hkl., North Mediterranean.	*Diphyes acuminata*, Leuck., North Mediterranean.
Cucullus gegenbauri, Hkl. (= *Eudoxia messanensis*, Ggbr.), South Mediterranean.	*Diphyes sieboldii*, Köll. (= *Diphyes gracilis*, Ggbr.), South Mediterranean.
Cucullus subtilis, Hkl., Mediterranean.	*Diphyes subtilis*, Chun, Mediterranean.
? *Cucullus elongatus*, Hkl., North Atlantic.	? *Diphyes elongata*, Hyndman; North Atlantic.
Cucullus lessoni, Lesson, Pacific.	*Diphyes appendiculata*, Esch., Pacific.
Cucullus gracilis, Hkl., Indian Ocean.	*Diphyes gracilis*, Hkl., Indian Ocean.
Amphiroa trigona, Hkl., Mediterranean.	*Abyla trigona*, Quoy, Mediterranean.
Amphiroa carina, Hkl., Tropical Atlantic.	*Abyla carina*, Hkl., Tropical Atlantic.
? *Amphiroa alata*, Huxley, Indian and Pacific Ocean.	? *Abyla alata*, Hkl., Indian and Pacific Ocean.
? *Amphiroa angulata*, Huxley, South Pacific.	? *Abyla leuckarti*, Huxley, South Pacific.
Sphenoides tetragona, Hkl., Indian Ocean.	*Bassia tetragona*, Hkl., Indian Ocean.
Sphenoides obeliscus, Hkl., North Atlantic.	*Bassia obeliscus*, Hkl., North Atlantic.
? *Sphenoides perforata*, Hkl., Tropical Atlantic.	? *Bassia perforata*, L. Ag., Tropical Atlantic.
Sphenoides australis, Huxley, South Pacific.	*Bassia quadrilatera*, Quoy, South Pacific.
Aglaisma eschscholtzii, Huxley, Mediterranean.	*Calpe pentagona*, Quoy, Mediterranean.
Aglaisma gegenbauri, Hkl., Tropical and Subtropical Atlantic.	*Calpe gegenbauri*, Hkl., Tropical and Subtropical Atlantic.
? *Aglaisma elongata*, Huxley, Tropical Pacific.	? *Calpe huxleyi*, Hkl., Tropical Pacific.
? *Ersæa gaimardi*, Esch., Mediterranean.	? *Diphyopsis campanulifera*, Hkl., Mediterranean.
Ersæa compressa, Hkl., Tropical Atlantic.	*Diphyopsis compressa*, Hkl., Tropical Atlantic.
Ersæa dispar, Hkl., Tropical Pacific.	*Diphyopsis dispar*, Hkl., Tropical Pacific.
? *Lilæa medusina*, Hkl., Indian Ocean.	? *Lilyopsis medusina*, Hkl., Indian Ocean.

Synopsis of the Families of Calyconectæ.

I. Suborder CALYCONECTÆ MONOGASTRICÆ. Cormus represented by a single cormidium, with a single siphon and a single tentacle.		Cormidium composed of two medusomes, a sterile and a fertile, without special nectophore, .	4. Eudoxidæ.
		Cormidium composed of three medusomes, a sterile, a fertile, and a special nectophore, .	5. Ersæidæ.
II. Suborder CALYCONECTÆ POLYGASTRICÆ. Cormus represented by a long tubular stem, which bears numerous ordinate cormidia, separated by free internodia; each cormidium with a siphon and a tentacle.	One or two nectophores on the top of the stem.	A single nectophore, .	6. Monophyidæ.
		Two nectophores, . .	7. Diphyidæ.
	A biserial nectosome on the top of the stem, composed of four to eight or more nectophores, opposite in pairs.	Each cormidium with a bract, ...	8. Desmophyidæ.
		Cormidia without bracts, .	9. Polyphyidæ.

Family IV. EUDOXIDÆ, Haeckel, 1888.

Eudoxidæ, Hkl., System der Siphonophoren, **95**, p. 32.

Definition.—Calyconectæ monogastricæ, representing a single cormidium, which is composed originally of two persons; a sterile medusome (siphon with tentacle and bract) and a fertile medusiform gonophore (male or female).

The family Eudoxidæ comprises those monogastric Calyconectæ which present in the fully developed and sexually mature state only a single cormidium, composed of two different medusomes, a sterile and a fertile. The sterile medusome is a bilateral medusoid person with three essential and constant organs, a bract (umbrella), a siphon (manubrium), and a tentacle (capturing filament). The fertile medusome is a gonophore with umbrella and manubrium, but without tentacles; the sexual cells are produced in the wall of the mouthless manubrium.

Eschscholtz (**1**, p. 124) in his System of the Diphyidæ, distinguished first two main groups in this family—I. Monogastricæ ("with a single suctorial tube"), *Eudoxia*, *Ersæa*, *Aglaisma*; and II. Polygastricæ ("with a long digestive tube bearing numerous suctorial tubes or lateral branches"), *Abyla*, *Cymba*, *Diphyes*.

Lesson (**3**, p. 437), adopting the division of Eschscholtz, and collecting the descriptions of other observers (mainly Quoy and Gaimard, **2** and **20**), described a greater number of "Diphyidæ monogastricæ," with not less than nine genera (*loc. cit.*, pp. 453–462). Some other species were described by Will (**65**) and Busch (**67**).

The true nature of the monogastric Diphyidæ (called usually *Eudoxiæ* sensu ampliori) was not recognised before 1853. In the spring of that year Gegenbaur discovered that

the cormidia of *Abyla pentagona*, detached from the common stem, live independently and develop into a sexual *Eudoxia*.[1] Leuckart, who had made the same observation simultaneously, demonstrated further that the monogastric *Eudoxia campanula* is nothing more than the detached cormidium of the polygastric *Diphyes acuminata* (**5**, pp. 41, 69 ; **8**, pp. 268, 277).

Huxley, in his excellent description of Diphyidæ, separated the monogastric forms or *Eudoxiæ* under the title "Diphyozooids."[2] He pointed out, with full reason, that it is necessary on practical grounds to retain generic and specific names for the single Diphyozooids, though they may possibly be only detached and independent portions of "Polygastric Diphyidæ." He gave a full anatomical description of many new or imperfectly known Eudoxiæ, and comparing their structure with that of the sessile cormidia of corresponding polygastric Diphyidæ, he suspected an ontogenetic connection between these two forms (*op. cit.*, 1859).

During my residence in the Canary Island, Lanzerote (in the winter of 1866–67), I had occasion to examine nearly all the interesting genera of Diphyozooids which Huxley had accurately described. I was able to confirm most of his suppositions concerning their connection with certain polygastric Diphyidæ, observing directly the development and detachment of the former from the latter (compare above, pp. 101, 102).

The metagenesis which connects the monogastric and polygastric Diphyidæ is usually combined with a peculiar metamorphosis, some interesting cases of which have recently been described by Chun (**86–88**).

The detached and independent cormidia of Calyconectæ—or the "Diphyozooids"—arise in two different main-forms, *Eudoxia* and *Ersæa*, which we regard here as representing two different families, Eudoxidæ and Ersæidæ. Each Eudoxia is composed of two medusoid persons, a sterile medusome (bract with siphon and tentacle) and a fertile medusome (gonophore). Ersæa differs from Eudoxia in the possession of a sterile "special nectophore," and is therefore composed of three medusomes.

The sterile medusome has in all Eudoxidæ the same characteristic composition of three essential parts—a bract (covering scale or hydrophyllium), a siphon placed in the dorsal part of the bracteal cavity, and a tentacle attached to the base of the siphon. The fertile medusome, or the gonophore, occupies the ventral part of the bracteal cavity.

Bract or Hydrophyllium.—The protectum or bract of each Eudoxia ("Deckstück or Deckblatt" of German authors) is the modified umbrella of the sterile medusome. This is very obvious in the genera *Eudoxella* (Pl. XXXII.) and *Aglaisma* (Pl. XL.), where the four radial canals of the subumbrella are preserved by heredity, whilst its muscle-plate is lost by adaptation ; furthermore, the jelly cap is strongly developed, forming a thick and firm protecting shield or cap ("covering scale").

Regarding the characteristic form of the bract, I distinguish two subfamilies among

[1] **4**, p. 78 ; **7**, p. 295, Taf. xvi. figs. 1, 2.

[2] **9**, pp. 57–66, pls. iii.–v.

the Eudoxidæ. The first group, Diplophysidæ, possess a smooth umbrella with rounded surface, never prismatic; hemispherical or mitriform in *Diplophysa* and *Eudoxella*, conical or spathiform in *Cucubalus* and *Cucullus*. The second subfamily, Aglaismidæ, has a polyhedral or prismatic umbrella with angular surface; it is more or less cuboidal in *Cuboides* and *Aglaisma*, wedge-shaped or similar to a prompter's box in *Sphenoides* and *Amphiroa*. The cuboidal form (Pls. XL., XLII.) is of special interest as a reminiscence of the quadriradial structure in the original umbrella of the ancestral Medusa.

Bracteal Cavity.—Whilst the superior or proximal face of the bract is convex, and corresponds to the exumbrella of the Medusa, its inferior or distal face is concave and comparable to the subumbrella. In the fundus of this cavity hangs the siphon, like the manubrium or gastral tube of the Medusa. Its point of insertion is usually dislocated towards the dorsal side. The single tentacle, which arises from the base of the siphon, is placed between this and the dorsal wall of the subumbrellar cavity. The greater ventral part of the cavity is occupied by the gonophore.

The form of the bracteal cavity has sometimes preserved the original hemispherical form of the subumbrella; but usually it is more campanulate or conical, and often at the same time bilateral, more rarely asymmetrical. Its basal opening, or the bracteal mouth, is usually oblique, more or less bevelled off, sometimes armed with prominent teeth.

Phyllocyst.—The central part of the subumbrella, where the siphon is inserted, contains in each Eudoxia a cæcal diverticulum of the entoderm, which is in direct communication with the basal part of the siphon, and in the young sessile Eudoxia with the central canal of the stem. This phyllocyst (bursa centralis bracteæ) is comparable to the apical canal, which in certain Medusæ (Codonidæ, &c.) ascends vertically from the base of the manubrium, and ends blindly in the jelly of the umbrella.

The cavity of the phyllocyst is usually small, lined by large clear vacuolated entoderm-cells, which are polyhedral from mutual pressure. The apical part of the phyllocyst usually contains an oleocyst (*co*), an oil-globule, which has a hydrostatic function. The phyllocyst of the bract is, therefore, similar to and comparable with the somatocyst of the nectophore.

The phyllocyst is sometimes a simple cylindrical cæcal canal or an ovate sac, placed in the vertical axis of the bract, or somewhat excentric; as in *Diplophysa*, *Cucubalus*, and *Cucullus*. But usually some nutritive canals arise from its base, which enter into the jelly mass of the bract. The number and disposition of these phyllocyst canals are characteristic of the different genera, and of interest as remnants of the four radial canals, which run in the subumbrella of Medusæ towards its margin. *Eudoxella* (Pl. XXXII.) and *Aglaisma* (Pl. XL.) still possess all four canals; two of them are placed in the sagittal plane (one dorsal and one ventral), two others symmetrically on both sides (one right and one left). The latter are preserved too in *Cuboides* (Pl. XLII.) and in *Amphiroa* (Pl. XXXVI.), whilst the two sagittal canals are lost. *Sphenoides* (Pl. XXXVIII.) possesses only a single canal, descending on the dorsal side; the three others have disappeared.

Siphon.—The single polypite of *Eudoxia*, or the manubrium of the sterile medusome, always exhibits the same structure as in other Calyconectæ. It is composed of four constant parts:—(1) A short pedicle (*sp*); (2) a thick-walled, usually hemispherical, basigaster, with masses of cnidoblasts (*sb*); (3) a dilated stomach, separated from the latter by a pyloric valve, and usually provided with liver-stripes (*sm*); and (4) a very extensile and contractile proboscis; the latter opens through the mouth, which often exhibits four or eight lobes. (Compare Pl. XXXII. fig. 8; Pl. XXXIV. figs. 9–11; Pl. XXXVIII. fig. 12; Pl. XL. figs. 13, 14, &c.)

Tentacles.—The single tentacle, which arises in each Eudoxia from the pedicle of the siphon, has usually the structure which is characteristic of the Calyconectæ. The long cylindrical and very contractile tubule is beset with numerous lateral branches or tentilla, separated by equal intervals. Each tentillum is composed of three parts, a slender pedicle, a reniform or ovate cnidosac, and a slender terminal filament. On the structure of the cnidosac compare above, p. 97.

Gonophores.—Each Eudoxia produces originally only a single gonophore, and this fertile medusome is placed in the ventral part of the bracteal cavity of the sterile medusome, before its siphon. In many species there is constantly found only a single gonophore, and when this becomes detached, it is usually soon replaced by a secondary or vicarious gonophore ("Ersatz-Geschlechts-Glocke"). But in some species usually two, or even three, gonophores are found at the same time developing in one bracteal cavity; they are usually of different sizes and ages, one placed at the right of the siphon, the other at its left (Pls. XXXIV., XLII.).

Eudoxiæ with a single gonophore are always gonochoristic, either male or female. When, however, two or three gonophores are developed simultaneously, then they are either of the same sex (*Eudoxiæ diclinicæ*, Pl. XLII. figs. 10, 14) or of different sexes (*Eudoxiæ monoclinicæ*, Pl. XL. fig. 14).

Each single mature gonophore of the Eudoxidæ is a well-developed quadriradiate Medusa, without mouth and tentacles, with sexual cells in the wall of the manubrium (spadix). The umbrella is rarely rounded, and without sharp edges, as in the gonophores of *Diplophysa* and *Eudoxella;* usually it is four-edged, prismatic or pyramidal; commonly two dorsal edges are more strongly developed, and more prominent over the basal ostium, than the two ventral edges. The apex of the umbrella is always prolonged into a beak-shaped apophysis or apical horn, the pedicle by which the gonophore is attached to the bracteal cavity. The quadriradial form of the umbrella in the single gonophore is usually symmetrical (with equal right and left halves); but when two gonophores are placed symmetrically on the two sides of one siphon, they are often modified by mutual pressure, and the single umbrella assumes an asymmetrical (sometimes pentagonal) form. (Compare p. 115, and Pl. XXXVI. figs. 12–25.)

Compare on the development of the Eudoxidæ above, pp. 100–102.

Synopsis of the Genera of Eudoxidæ.

I. Subfamily DIPLOPHYSIDÆ. Bracts not polyhedral, never prismatic, without complete sharp edges and polygonal faces. (Exumbrella rounded and smooth, not facetted.)	Bract hemispherical or mitriform, rounded, without sharp edges, and without pointed apex.	Phyllocyst simple, without radial canals,	10. *Diplophysa.*
		Phyllocyst with four radial canals arising from its base,	11A. *Eudoxella.*
	Bract conical, spathiform or pyramidal, with a pointed apex, and often with some incomplete edges.	Phyllocyst simple. Bracteal exumbrella smooth, with no sharp edge,	11B. *Cucubalus.*
		Phyllocyst simple. Bracteal exumbrella with three or five edges,	12. *Cucullus.*
II. Subfamily AGLAISMIDÆ. Bracts polyhedral, more or less prismatic, with many sharp edges and polygonal faces. (Exumbrella facetted and angular.)	Bract more or less cuboidal, with an inferior opening into its cavity at the basal face.	Phyllocyst with two lobate lateral canals. Bract without caudal apophysis,	13. *Cuboides.*
		Phyllocyst with four cruciate radial canals. Bract with a pyramidal caudal apophysis,	16. *Aglaisma.*
	Bract not cuboidal, with an anterior opening into its cavity at the obliquely bevelled ventral face.	Phyllocyst descending, with two superior lateral canals. Bract with five odd trapezoidal and two paired pentagonal faces,	14. *Amphiroa.*
		Phyllocyst ascending, with an odd inferior canal. Bract with four odd and four paired faces,	15. *Sphenoides.*

Genus 10. *Diplophysa*,[1] Gegenbaur, 1854.

Diplophysa, Ggbr., Zeitschr. f. wiss. Zool., Bd. v. p. 291.

Definition.—Eudoxidæ with a hemispherical or subspherical bract, without sharp edges, in the vertical axis of which is placed a simple ovate or cylindrical phyllocyst. (Eudoxiæ of the genus *Sphæronectes.*)

The genus *Diplophysa* comprises those monogastric Eudoxidæ which arise from the polygastric Monophyid genus *Sphæronectes* (Genus 18). It was founded in 1854 by Gegenbaur for a Mediterranean Eudoxia, distinguished by a subspherical bract with a simple phyllocyst.[2] It is very similar to another Mediterranean species, described in 1844 by Will under the name *Ersæa truncata.*[3] Thirty years later Claus (70) demon-

[1] *Diplophysa* = Double vesicle, διπλοα, φῦσα.

[2] 7, p. 291, Taf. xvi. fig. 3.

[3] 65, p. 82, Taf. ii. fig. 28.

strated that this monogastric Calyconecta is the detached free Eudoxia of a polygastric Monophyid, which was first described in 1859 by Huxley as *Sphæronectes köllikeri* (9, p. 50). He called it *Monophyes gracilis* (compare below the descriptions of Genera 18 and 19). The peculiar metagenesis of these two forms of Calycophoridæ was afterwards accurately described by Chun (86, 87).

A few Eudoxiæ of this genus were found by me in a bottle in the Challenger collection, taken in the Tropical Pacific, Station 274. Since the same bottle contained a specimen of *Sphæronectes köllikeri*, it is probable that they were detached from the latter. I call them *Diplophysa köllikeri*.

Diplophysa differs from all other Eudoxidæ in the hemispherical, or nearly spherical, form of its bract, and the simple ovate or cylindrical shape of its phyllocyst, which ascends vertically in the axis of the bract. In the centre of the shallow subumbral cavity of the bract is suspended a hemispherical gonophore, of about the same size, and between these two, at the ventral face of the latter, is a simple siphon with its tentacle.

Genus 11A. *Eudoxella*,[1] Haeckel, 1888.

Eudoxella, Hkl., System der Siphonophoren, p. 32.

Definition.—Eudoxidæ with a mitriform, helmet-shaped, or hemispherical bract, the exumbrella of which is smooth and without sharp edges. Phyllocyst with four radial canals arising from its base. (Eudoxiæ of the genus *Praya?*)

The genus *Eudoxella*, as defined in my System, comprises free Eudoxiæ, the bract of which is essentially identical with that of the sessile cormidia of *Praya* (Pl. XXXII.). I suspect, therefore, that this genus is the monogastric generation of a true polygastric *Praya*. But the well-known species of this latter (*Praya galea*, *Praya maxima*, *Praya cymbiformis*) are generally assumed to possess eudoxomes, which become mature whilst still attached to the common stem. The question, however, whether this holds good as a general rule, requires further accurate examination.

A bottle in the Challenger collection, containing surface animals taken in the Tropical Atlantic (Station 343, April 10, 1876), contained a few specimens of a *Eudoxella*, which is very similar to the sessile eudoxome of *Praya galea* (Pl. XXXII.). But the helmet-shaped bract was more highly vaulted, and the four radial canals, arising from the base of the phyllocyst, were shorter and more equally disposed. The main difference was indicated by the remarkable fact, that each Eudoxia exhibited no trace of the stem of a *Praya*, and contained a large, completely mature gonophore. It is therefore probable that this Eudoxia, which I call *Eudoxella didyma*, may be the detached cormidium of some unknown species of *Praya* (*Praya cymbiformis?*), the gonophores of which are not brought to maturity whilst sessile on the stem.

[1] *Eudoxella* = Small Eudoxia.

Genus 11B. *Cucubalus*,[1] Quoy et Gaimard, 1824 (MS.).

Cucubalus, Blainville, Manuel d'Actinologie, 1834, p. 130.

Definition.—Eudoxidæ with a conical, spathiform or cordiform bract, obliquely bevelled on the ventral side, evenly convex on the smooth dorsal side, pointed at the apex. Phyllocyst simple, ovate. (Eudoxiæ of the genus *Muggiæa*.)

The genus *Cucubalus* was founded by Quoy and Gaimard (**2**, pl. iv. figs. 24, 27) upon a Eudoxia from the Tropical Pacific, which Blainville afterwards described as *Cucubalus cordiformis* (**24**, p. 130). It may be, perhaps, the monogastric generation of *Muggiæa chamissonis* (=*Diphyes chamissonis*, Huxley, **9**, pl. i. fig. 3). The best known representative of the genus is the Mediterranean *Cucubalus eschscholtzii*, which was described by Busch as *Eudoxia eschscholtzii*.[2] Its development from the polygastric *Muggiæa kochii*, and the regular metagenesis of these two forms, were afterwards described very accurately by Chun (**86**, **87**). A similar and nearly allied species was observed by me in 1866 in the Canary Island, Lanzerote, and I found it again in some bottles from the Challenger collection taken in the Tropical Atlantic (Stations 348, 352). This Atlantic species may retain the name of *Cucubalus pyramidalis*, and its polygastric generation *Muggiæa pyramidalis*, with respect to the original names of Busch and Will (compare Chun, **85**).

The genus *Cucubalus* is closely allied to the following *Cucullus*, the monogastric generation of *Diphyes*. It differs from the latter in the smooth and edgeless shape of the bract, which is more rounded and not pyramidal.

Genus 12. *Cucullus*,[3] Quoy et Gaimard, 1824 (MS.).

Cucullus, Blainville, Manuel d'Actinologie, 1834, p. 131.

Definition.—Eudoxidæ with a cowled or cucullate, sometimes three-sided pyramidal bract, open at the bevelled ventral side, evenly convex, or sometimes with three incomplete edges on the dorsal side, pointed at the apex. Phyllocyst simple and conical. (Eudoxiæ of the genus *Diphyes*.)

The genus *Cucullus* contains those monogastric Eudoxidæ which arise from the polygastric genus *Diphyes*, in the restricted sense in which recent authors have employed it, and which we have accepted. The bract is irregularly conical, or pyramidal, with a deep ventral fissure, which passes into the obliquely truncated cavity. Its dorsal face is either evenly convex, or slightly three-sided, its apex pointed. The inferior half of the spathiform bract embraces the included siphon and gonophore like a mantle, and

[1] *Cucubalus*=Name of a plant.

[2] **67**, p. 33, Taf. iv. figs. 7–10; and Taf. v. figs. 1–9.

[3] *Cucullus*=Cowl.

often one of its free ventral margins overlaps the other; the superior half is comparable to the cowl of the mantle, and includes the simple ovate ascending phollocyst. The free inferior part of the mantle-lobes often exhibits two small prominent teeth.

The genus *Cucullus* was founded by Quoy and Gaimard upon an Australian Eudoxia, which they figured first under the name *Diphyes cucullus* (**2**, p. 92), synonymous with *Eudoxia lessonii* of Eschscholtz (**1**, p. 126). Blainville called the former in 1834 *Cucullus doreyanus* (**24**, p. 131), and Lesson himself separated the latter as *Cucullus lessonii* (**3**, p. 459). Indeed the genus *Cucullus* of the French authors (published in 1834) is identical with *Eudoxia* of Eschscholtz (1829). But since Gegenbaur and Leuckart, in 1853, demonstrated that the Eudoxiæ are the isolated cormidia of Diphyidæ, the term *Eudoxia* is generally used for all these "Diphyozooids" (Huxley, 1859, **9**, p. 57). It seems, therefore, best, to avoid further confusion—to employ the term *Cucullus* for the monogastric generation of those Diphyidæ which constitute the genus *Diphyes* in the strictest sense (compare below, Genus 27). The typical and oldest species remains *Cucullus lessoni*, as the free Eudoxia of the Pacific *Diphyes appendiculata*, Esch.

Scarcely different from *Cucullus* is the genus *Cucubalus* of Quoy and Gaimard. This genus, however, may be retained for the Eudoxiæ of the Monophyid *Muggiæa*, which are very similar to those of *Diphyes*. (Compare the preceding genus.)

Many bottles of surface animals in the Challenger collection contained specimens of Eudoxiæ belonging to *Cucullus*, and in some cases it was possible to demonstrate their connection with a species of *Diphyes* contained in the same bottle as the former. Supported by the comparative study of these forms, and of similar forms compared in other collections, and partly observed living by myself, I have been led to state the ontogenetic connection of the following species of monogastric *Cucullus* with corresponding species of polygastric *Diphyes*:—

1. *Cucullus lessoni*, Lesson (**3**, p. 459), synonymous with *Eudoxia lessonii*, Eschscholtz (**1**, p. 126), is the free Eudoxia of *Diphyes appendiculata*, Esch. (**1**, p. 138), taken in the Pacific.
2. *Cucullus gracilis*, Hkl., synonymous with *Eudoxia bojani*, Esch. (**1**, p. 125) and Huxley (**9**, p. 59), is the free Eudoxia of *Diphyes gracilis*, Hkl., taken in the Southern Pacific and in the Indian Ocean.
3. *Cucullus elongatus*, Hkl., is the free Eudoxia of *Diphyes elongata*, Hyndman (**64**, p. 166), occurring in different parts of the Northern Atlantic, Gulf Stream, &c.
4. *Cucullus gegenbauri*, Hkl., synonymous with *Eudoxia messanensis*, Ggbr. (**7**, Taf. xvi. fig. 4), is the free Eudoxia of *Diphyes sieboldii*, Köll. (**4**, Taf. xi.), Mediterranean and Tropical Atlantic.

5. *Cucullus campanula*, Hkl., synonymous with *Eudoxia campanula*, Leuckart (5, p. 43), is the free Eudoxia of *Diphyes acuminata*, Leuck. (5, Taf. iii.), inhabitant of the Mediterranean.
6. *Cucullus subtilis*, Hkl., synonymous with *Ersæa elongata*, Will (65, p. 82, Taf. ii. fig. 30), is the free Eudoxia of *Diphyes subtilis*, Chun (88, p. 687), also Mediterranean.

Genus 13. *Cuboides*,[1] Quoy et Gaimard, 1827.

Cuboides, Quoy et Gaimard, Ann. d. Sci. Nat. (Zool.), t. x. p. 19.

Definition.—Eudoxidæ with a cuboidal bract, bounded by six quadrangular faces, twelve edges, and eight angles. Phyllocyst composed of a slender vertical canal, and two broad horizontal lateral lobes at its base. (Eudoxiæ of the genus *Cymba*.)

The genus *Cuboides* (Pl. XLII.) comprises those very remarkable monogastric Eudoxidæ, which arise from the polygastric Monophyid genus *Cymba* (Genus 23, Pl. XLI.). Its bract has the extraordinary form of a subregular cube, and is distinguished by a very characteristic phyllocyst. This is composed of a slender, vertically ascending canal, which usually includes an oleocyst; and a wide basal diverticulum, which is divided into two broad, horizontally diverging, and ventrally directed lobes. We may compare these latter with the two symmetrical lateral canals of a bilateral Medusa, whilst the ascending canal corresponds to the odd ventral vessel. The fourth, dorsal and descending canal (preserved in *Aglaisma*) is lost in *Cuboides*. The basal diverticulum of the latter is the proper phyllocyst.

The genus *Cuboides* was founded by Quoy and Gaimard (*loc. cit.*) upon an isolated Eudoxia, found in the Straits of Gibraltar, and called *Cuboides vitreus*. This is probably the detached monogastric form of the polygastric *Cymba enneagonum* found by the French authors at the same locality. It seems different from the species occurring in the Eastern Tropical Atlantic, and figured by me in Pl. XLII. as *Cuboides crystallus*. The figures and descriptions of the French authors are too insufficient to identify the two forms. The first accurate description of this peculiar Eudoxia, its cuboidal hydrophyllium and bilobed phyllocyst, was given in 1859, by Huxley (9, p. 63, pl. iv. fig. 5). He took it twice, once on the east coast of Australia, and once on the south coast of New Guinea, called it *Cuboides vitreus*, and suspected, rightly, that it might be derived from his *Abyla vogtii* (*loc. cit.*, pl. ii. fig. 3). Different from this Australian species is an Indian species (*Cuboides nacella*, Hkl.), and the Atlantic species, which I shall describe in the sequel. It occurred in a bottle of the Challenger collection, from Station 352, near the Cape Verde Islands. I myself examined this species living in the Canary Islands in February 1867, and observed directly its origin and detachment from the polygastric Monophyid *Cymba crystallus* (compare below, Genus 23).

[1] *Cuboides* = Cuboidal, κυβοειδής.

Cuboides crystallus, n. sp. (Pl. XLII.).

Habitat.—Tropical and Subtropical Atlantic, Station, 352; lat. 10 °55′ N.; long. 17° 46′ W. Surface.

Canary Islands, Lanzerote, February 1867 (Haeckel).

Bract (fig. 9, *u*, lateral view from the right side; fig. 10, *u*, dorsal view; fig. 13, *u*, basal view; fig. 14, *w*, apical view; figs. 11, 12, a younger specimen, seen from the left and from the dorsal sides respectively).—The hydrophyllium or bract is very large (10 to 12 mm. diameter), nearly cuboidal, with six flattened, slightly concave, quadrangular faces, twelve serrate, slightly concave edges, and eight prominent, three-sided pyramidal angles. The six faces are of nearly equal size, the apical face (*ua*) somewhat smaller, and the basal face a little larger than the four lateral faces (*ud*, dorsal; *uv*, ventral; *ux*, right; *ul*, left). The basal, inferior or distal face is occupied by a wide, flatly conical, subumbrellar cavity (*ui*), its apex reaches the centre of the cube.

Phyllocyst (*cs*).—The apical canal of the bract, or the phyllocyst, consists of two very different parts, the axes of which are nearly perpendicular one to another. The slender apical part is subvertical, spindle-shaped, includes a fusiform oleocyst (*co*), and touches with its apex the centre of the concave apical face of the bract (*ua*). The dilated basal part of the phyllocyst, however, is divided into two broad ovate horizontal lobes (*cs″*, right; *cs′*, left); these are filled up with large clear entoderm cells, directed towards the ventral face of the bract (*uv*), and embrace the uppermost part of the peduncle of the siphon (*s*).

Siphon (*s*).—The siphon or polypite is pyriform, very contractile, suspended in the top of the subumbrellar cavity, and exhibits a pale yellowish colour. Its short pedicle bears at its thickened base, on its dorsal side, the tentacle (*t*); on its ventral side are placed one or two gonophores (*g*).

Tentacle (*t*).—The single tentacle of this cuboidal Eudoxia is usually coiled up and hidden in the dorsal part of the infundibular cavity, behind the siphon. The tentilla or secondary filaments (fig. 16) have a thin pedicle (*ts*) and a simple terminal filament (*tf*), and between them a large reniform sacculus. This cnidosac has a leather-yellow or reddish-yellow colour, and contains on the convex dorsal side numerous (six to nine) rows of medial cnidocysts (*km*), and on each side of this battery, in the proximal part, a series of six to nine very large, spindle-shaped, lateral cnidocysts (*kg*); at the distal end a small group of small pyriform cnidocysts.

Gonophores.—The Eudoxiæ develop in the bracteal cavity, on the ventral side of the siphon, either male or female gonophores. The young Eudoxiæ (figs. 11, 12) exhibit only one gonophore, the older two or three (figs. 9, 10, 13, 14). The umbrella of the gonophores (or the gonocalyx) is quadrangular, slightly bilateral, a little asymmetrical.

Its superior or proximal half has four smooth edges, is pyramidal, and forms a prominent ventral crest. Its inferior or distal part is a quadrilateral prism with four strong serrate edges, prominent below as four three-sided pyramidal apophyses, the two dorsal far larger than the two ventral (fig. 11).

Canal of the Gonophores (fig. 17, *cp*).—This is long, peduncular, and divides at the apex of the subumbrella (*w*) into four rather regular radial canals (*cr*). These exhibit an elegantly pinnulated appearance, produced by alternately prominent small diverticula. They are connected at the base of the large velum (*v*) by a circular canal (*cc*).

The *ovaria* (fig. 17, *o*), as well as the *spermaria* (figs. 9–14, *hm*), are spindle-shaped manubria, which hang freely in the upper half of the umbrellar cavity of the gonophores. They contain a large central cavity (spadix).

Genus 14. *Amphiroa*,[1] Blainville, 1834.

Amphiroa, Blainville, Manuel d'Actinologie, p. 133.

Definition.—Eudoxidæ with a bilateral, prismatic bract, bounded by five odd trapezoidal faces and two paired pentagonal faces. Phyllocyst composed of an ovate descending dorsal sac, and two slender horizontally diverging lateral canals at its apex. (Eudoxiæ of the genus *Abyla*.)

The genus *Amphiroa* (Pl. XXXVI.) comprises those monogastric Eudoxidæ which arise from the polygastric Diphyid genus *Abyla* (Genus 29, Pl. XXXV.). Its bract has a peculiar and very complicated form, which may best be compared with a prompter's box. It is composed of two four-sided prisms, which are united at right angles. The vertical prism covers the dorsal side of the Eudoxia, and is nearly filled up by a very large sac-shaped phyllocyst. From the apex of the latter arise two divergent lateral canals which run horizontally in the second prism, covering the apical face of the Eudoxia.

The genus *Amphiroa* was first observed and named by Lesueur (probably in 1803), but first published from his drawings by Blainville, in 1834.[2] A very accurate description of it was given in 1859 by two excellent observers, Huxley (**9**, p. 64) and Gegenbaur (**10**, p. 17). These two authors, independently of each other, arrived at the same opinion, that *Amphiroa* is the free Eudoxia of *Abyla trigona*. The latter, therefore, called it *Eudoxia trigonæ*. We retain this name for the Mediterranean species, whilst *Amphiroa alata* of Huxley is the Eudoxia of *Abyla alata*, inhabiting the Tropical Pacific and Indian Ocean. A third species, described by Huxley as *Amphiroa angulata* (**9**, pl. v. fig. 2), is probably the Eudoxia of *Abyla leuckarti*, Huxley. Different from these three species is *Amphiroa carina*, which occurred in a bottle in the Challenger collection, taken at Station 348. I myself observed this species living, and detaching itself from *Abyla carina*, in February 1867, in the Canary Islands.

[1] *Amphiroa*, Ἀμφίρῳ, a daughter of Okeanos.

[2] **24**, p. 133, Atlas, pl. iv. fig. 1.

Amphiroa carina, n. sp. (Pl. XXXVI.).

Habitat.—Tropical and Subtropical Atlantic, Station 348 ; April 9, 1876 ; lat. 3° 10′ N., long. 14° 51′ W. Surface.

Canary Islands, Lanzerote, February 1867 (Haeckel).

Bract (figs. 14, 19, and 21, ventral view ; fig. 15, dorsal view ; fig. 16, apical view ; figs. 17 and 20, basal view ; figs. 13 and 18, lateral view from the left side ; fig. 12, lateral view from the right side. Figs. 12 and 13 taken from immature Eudoxomes, sessile on the stem).—The bract or hydrophyllium has a diameter of 6 to 8 mm., and in general the form of a prompter's box ; it may be described as a bilateral polyhedron, which is composed of two four-sided prisms united perpendicularly ; the superior or horizontal prism includes the two diverging horizontal phyllocyst canals ; the posterior or vertical prism includes the large vertically depending phyllocyst. The obliquely bevelled ventral face of the bract (the inferior face of the first, and the anterior face of the second prism) is deeply excavated, and encloses the siphon and the gonophores.

The horizontal apical or superior face (fig. 16) is trapezoidal, the ventral edge three times as long as the parallel dorsal edge ; the two equal lateral edges are concave, as long as the former, and diverge ventrally.

The vertical dorsal or posterior face (fig. 15, *ud*), through which the phyllocyst (*bc*) shines, is also trapezoidal, the basal edge twice as long as the parallel apical edge and half as long as the two lateral edges, which are slightly concave, and diverge towards the base.

The two lateral faces of the bract (figs. 12, 18, between ventral and dorsal faces) are concave, irregularly pentagonal, nearly vertical, and divergent from the dorsal to the ventral side. The superior horizontal and the posterior vertical edge of the pentagon are the longest, of nearly equal size, and meet at right angles (in the apical corner of the dorsal face). The vertical anterior and the horizontal inferior edge are only half as long as the former. The ventral (or antero-basal) edge of the pentagon, between the anterior and inferior edges, is deeply emarginate and serrate.

The horizontal basal or inferior face of the bract (fig. 17, *ub*) is nearly square, and the smallest of all its six faces. Its ventral edge is bisected by the prominent median groove of the bract-cavity.

The ventral or anterior face of the bract (figs. 14, 21) has the most complicated form of all six faces, and is deeply excavated by the cavity which includes the siphon and the gonophores. The ventral opening of this cavity has again a trapezoidal outline ; its upper horizontal edge is three times as long as the parallel basal edge, and somewhat longer than the two dentate lateral edges which diverge upwards. The superior part of the ventral face, above the opening of the cavity, is formed by a broad frontal face through

which the two phyllocyst-canals shine. This facet is nearly rectangular, its horizontal inferior edge somewhat longer than the parallel superior, and three times as long as the two short lateral edges which diverge downwards.

The bract of the young Eudoxomes, sessile on the stem (fig. 13), exhibits the characteristic form of the adult to a much less degree, and has a more irregular cuboidal form. The bract of the young, just detached Eudoxia (figured in fig. 12, *b*), forms the transition from the latter to the former.

Bracteal Cavity (figs. 12, 18, *bh*).—The subumbrellar cavity of the hydrophyllium is deeply campanulate or nearly conical, somewhat compressed from both lateral sides. Its posterior or dorsal wall is nearly vertical and touches the siphon and the tentacle. Its anterior half is filled up by one or more gonophores. The inferior and anterior trapezoidal opening of the cavity has been already described.

Phyllocyst (figs. 12–18, *bc*).—The canal system of the bract is composed of a very large dorsal sac-shaped phyllocyst, which stands vertically, and of two slender horizontal canals, which arise from the apex of the former and diverge laterally. The large phyllocyst occupies nearly the dorsal half of the bract, and is a vertical cylinder with rounded basal faces, or nearly ellipsoidal, three times as long as broad. Its small internal cavity is surrounded and almost filled with very large vacuolate entoderm-cells.

The two paired lateral canals of the bract (figs. 12–18, *cx* right, *cl* left), which arise from the apex of the phyllocyst at right angles, are slender and run divergently towards the two frontal corners of the bract, in their first half horizontally, in the second curved upwards. Their blind distal ends (at the junction of the apical, ventral, and lateral faces) are somewhat club-shaped.

Siphon (figs. 12, 13, 21, *s*).—The polypite is hidden in the dorsal part of the bracteal cavity, and exhibits the usual structure of the Calyconectæ—a short pedicle, a thick-walled basigaster, a wide stomach with hepatic stripes, and a proboscis with a four- or eight-lobed mouth.

Tentacle (figs. 12, 13, *t*, 26).—The single tentacle, which arises from the pedicle of the siphon, exhibits the same structure as that of other Abylidæ. Each tentillum bears on its pedicle (fig. 26, *ts*) a slender reniform cnidosac, and in the proximal part of this six to eight large spindle-shaped cnidocysts at each side of the cnido-battery (*kg*). The terminal filament (*tf*) is slender and long.

Gonophores (figs. 22–25, isolated; figs. 12–19, included in the cavity of the bract).—Each ripe Eudoxia usually bears a pair of gonophores in the ventral part of its cavity, before the siphon. The two gonophores, right and left, are so transformed by mutual pressure that their umbrella or gonocalyx (originally a tetragonal prism) assumes an asymmetrical pentagonal form. The inner or medial faces (in which the two neighbouring gonophores meet in the sagittal plane of the bract) are flattened, whilst the outer or lateral faces are prominent above, in form of a lateral horn. One of the five edges

(n^7) is dentate. The five teeth of the basal mouth are very unequal, two much larger than the three others. The two paired gonophores together form a double body of bilaterally symmetrical form. Sometimes they are of the same sex, at other times of different sexes.

Genus 15. *Sphenoides*,[1] Huxley, 1859.

Sphenoides, Huxley, Oceanic Hydrozoa, p. 61.

Definition.—Eudoxidæ with a bilateral prismatic or sphenoidal bract, bounded by eight faces, twelve edges, and twelve angles. Phyllocyst composed of a large apical sac and a slender odd dorsal canal descending from the base of the sac. (Eudoxiæ of the genus *Bassia*.)

The genus *Sphenoides* (Pl. XXXVIII.) comprises those monogastric Eudoxidæ which arise from the polygastric Diphyid genus *Bassia* (Genus 30, Pl. XXXVII.). Its bract has a very complicated sphenoidal form, and is distinguished by a large ovate sac of the phyllocyst in the apical half of the umbrella, whilst a long slender odd dorsal canal (similar to a basal spur) descends into the basal half. The original main axis of the umbrella is strongly curved, so that its ventral part is shortened and its dorsal part correspondingly expanded. The twelve edges of the wedge-shaped umbrella are produced into twelve three-sided pyramidal teeth, five of which belong to the ventral (u^1–u^5), seven to the dorsal half (u^6–u^{12}). The eight faces of the umbrella are four larger paired lateral (a superior pair quadrangular, an inferior pair hexagonal) and four smaller odd frontal faces, two superior triangular (one ventral and one dorsal) and two inferior (a triangular dorsal and a hexagonal basal). The comparison of the young bract (Pl. XXXVIII. fig. 13) and the adult (fig. 14) exhibits the curious development of this cuneiform hydrophyllium.

The genus *Sphenoides* was founded by Huxley (*loc. cit.*) upon an Australian species, which he rightly suspected to be the Diphyozooid of *Abyla bassensis* (= *Bassia quadrilatera*). This species is rather different from the Atlantic species described in the following, the development of which from *Bassia* I observed in the Canary Islands; and from another species (*Sphenoides tetragona*) which I observed in the Indian Ocean. A fourth species may be the Eudoxia of the South Atlantic, *Bassia perforata* (10).

Sphenoides obeliscus, n. sp. (Pl. XXXVIII.).

Habitat.—Northern Atlantic; Canary Islands, Lanzerote, February 1867 (Haeckel).

Bract (fig. 12, *u*, lateral view from the left side, with the included parts; figs. 13 and 14, lateral view from the right side; fig. 13, of a younger attached Eudoxia; fig. 14, of

[1] *Sphenoides* = Wedge-shaped, σφηνοειδης.

an older free Eudoxia).—The hydrophyllium or bract has a diameter of 10 to 12 mm., and a sphenoidal or wedge-shaped, rather complicated form, which is best understood if we imagine the true axis of the umbrella standing vertically, its upper or apical pole marked by the top, the lower or basal pole by the centre of the aperture of the cavity. The latter (or the original ostium subumbrellæ) is surrounded by five prominent points, an odd dorsal basal point (u^8) and four paired lateral; two of these are dorso-lateral basal points (u^6 right, u^7 left), the two others ventro-lateral basal points (u^4 right, u^5 left).

The opposite apical or superior part of the ripe bract (fig. 14) has the form of a house-roof or of a triangular prism, inclined ventrally. The apical crest (*nk*) is strongly inclined towards the ventral side, so that the dorsal apical point (u^{12}) may be regarded as the original apex of the bilateral umbrella. The opposite ventral apical point (u^1), on the contrary, marks the upper pole of the curved axis of the phyllocyst (*bc*).

The ventral face of the bract is pentagonal and marked by five prominent points, one odd and four paired. The odd is the above-mentioned ventral apical point (u^1). The upper pair of points are the ventro-lateral apical (u^2 right, u^3 left); the lower pair of points are the ventro-lateral basal points (u^4 right, u^5 left).

The dorsal face of the bract is quadrangular in the upper part, crest-shaped in the lower part, and is marked by five points, three odd and two paired. The uppermost is the odd dorsal apical point (u^{12}), the lowermost the odd dorsal basal point (u^8), the hindermost (between the former) the odd dorsal caudal point (u^9). At the right side (u^{10}) and left side (u^{11}) the two dorso-lateral points are prominent. The wedge-shaped dorsal crest (*ng*) is in the ripe bract (fig. 14) opposite and parallel to the apical crest (*nk*). All crests and edges of the bract are elegantly denticulated.

The mature bract of the free Eudoxia (fig. 14) differs from the young bract of the sessile Eudoxoma (fig. 13) mainly in the development of a pair of arched prominent transverse ridges or girdle-wings (u^2, u^{10}, right; u^3, u^{11}, left). These separate more distinctly the thicker apical half of the hydrophyllium from its thinner ventral half. An accurate comparison of fig. 13 (young) and fig. 14 (adult) will explain the other differences of these two forms, which are produced by further growth.

Bracteal Cavity (figs. 13, 14, *bh*, seen from the right side).—The subumbrellar cavity has the form of a helmet or a Phrygian cap; it is campanulate, with strongly curved axis, concave at the ventral, convex at the dorsal side. The cavity occupies in the young bract (fig. 13) about two-thirds of the whole body; in the adult (fig. 14) only the basal half. Its basal aperture, or the original mouth of the umbrella, is armed with five large triangular, pyramidal points or teeth, one odd and four paired; the posterior odd tooth (u^8) is the dorsal basal point; the two ventro-lateral basal teeth (u^4, u^5) are larger and wider apart than the two dorso-lateral basal teeth (u^6, u^7). A deep ventral groove, through which passes the stem of the cormus (fig. 13, *a*), is placed in the sagittal plane of the bract, immediately to the ventral side of the subumbrellar cavity (*bh*).

Phyllocyst (fig. 13, *bc*).—The canal system of the bract is composed of three parts of a large ovate phyllocyst (*bc*), a short peduncular canal, and a long dorsal cæcum. The small peduncular canal arises from the common stem (*a*), and runs immediately to the ventral base of the large ovate phyllocyst (*bc*). This latter is placed in the apical half of the bract, and contains in its uppermost part a spherical oleocyst (*co*). Its rounded apex does not reach the apical crest (*nk*). The dorsal canal (*cd*) is a slender cæcum, which arises from the base of the phyllocyst, and runs along the dorsal median line of its cavity, separated from it by a thin jelly-plate. The dorsal canal is therefore spur-shaped and crooked, concave on the ventral, convex on the dorsal side. Its blind lower end does not reach the basal edge (*ng*).

Siphon (fig. 12, *s*).—The polypite or siphon is suspended in the top of the subumbrellar cavity of the bract, and may be completely hidden in it. From its short pedicle arises the tentacle (*t*). A pyloric valve separates the thick basigaster (*sb*) from the stomach, which exhibits eight yellow striæ hepaticæ. The proboscis (*sr*) is very contractile; its mouth exhibits sixteen short indentations.

Tentacle (fig. 12, *t*).—The single tentacle of the siphon is distinctly segmented by numerous constrictions, and from each constriction arises a tentillum. The pedicles (*ts*) and the terminal filaments (*tf*) of the tentilla are long and slender. The reniform cnidosac exhibits on its convex side six to eight longitudinal rows of medial cnidocysts (fig. 16, *km*), on both sides of its base a group of large spindle-shaped lateral cnidocysts (*kg*), and at the distal end a group of small pyriform cnidocysts (*kp*).

Gonophores (fig. 12, *h*; fig. 15).—The sexual Medusa which arises from the stem at the ventral side of the siphon, has a four-winged umbrella, which is pyramidal in the smaller apical half, prismatic in the larger basal half. Its four prominent and denticulate wings are unequal in pairs in the younger gonophores, the two dorsal wings (fig. 12, *hu*) being much larger than the two ventrals; afterwards (fig. 15) they become nearly equal. A long peduncular canal (fig. 15, *cp*) runs through the pedicle of the umbrella to the top of the subumbrella (*w*), and divides here into four equidistant radial canals. The spindle-shaped spermaria of the male gonophore (fig. 12, *hs*), and the ovate or subspherical ovaria of the female (fig. 15, *o*), occupy the apical half of the subumbrellar cavity.

Genus 16. *Aglaisma*,[1] Eschscholtz, 1829.

Aglaisma, Eschscholtz, System der Acalephen, p. 129.

Definition.—Eudoxidæ with a bilateral prismatic bract, which is cuboidal in the larger upper part, obliquely pyramidal in the smaller lower part. Phyllocyst with four cruciate radial canals, two odd sagittal (an ascending and a descending) and two paired lateral canals. (Eudoxiæ of the genus *Calpe*.)

[1] *Aglaisma*, ἀγλάισμα = Ornament.

The genus *Aglaisma* (Pl. XL.) comprises those monogastric Eudoxidæ which arise from the polygastric Diphyid genus *Calpe* (Genus 31, Pl. XXXIX.). Its bract is nearly cuboidal, similar to that of *Cuboides* (Genus 13), but differing from it in the possession of a pyramidal, trigonal, or pentagonal apophysis, which descends vertically from the dorsal and basal part of the cube. It is further distinguished by the possession of four radial canals, arising from the small subcentral phyllocyst. Two of these four cruciate canals are slender and vertical (an ascending and a descending), two others sacculate and horizontal (a right and a left).

The genus *Aglaisma* was founded in 1829 by Eschscholtz for a Tropical Atlantic species of monogastric Diphyidæ, which he called *Aglaisma baeri* (**1**, p. 129); it is possibly identical with our *Aglaisma gegenbauri*. Afterwards Huxley,[1] in 1859, gave an accurate description of two nearly related species, which he called *Aglaismoides eschscholtzii* and *Aglaismoides elongata*. He suspected rightly that the former might be the Eudoxia of the common Mediterranean *Abyla pentagona*. The other species, *Aglaismoides elongata*, might be the Eudoxia of *Calpe huxleyi*. During my stay in the Canary Islands (1867) I observed the development of the species described in the following pages, from *Calpe gegenbauri*. It occurs also in a bottle of the Challenger collection, taken at Station 346.

Aglaisma gegenbauri, n. sp. (Pl. XL.).

Habitat.—Tropical and Subtropical Atlantic, Station 346; April 6, 1876; lat. 2° 42′ S., long. 14° 41′ W. Surface.

Canary Islands, Lanzerote, February 1867 (Haeckel).

Bract (fig. 13, *b*, lateral view from the right side; fig. 14, *b*, from the left side; fig. 15, basal view; fig. 16, apical view; fig. 17, dorsal view; fig. 18, ventral view).—The hydrophyllium or bract is subregularly cuboidal in its apical or superior half, in its basal or inferior obliquely pyramidal, bevelled off at the ventral and basal face. The length or height of the bract is 1·2 to 1·5 mm., the breadth 0·6 to 0·8 mm.

The apical or superior face of the bract (figs. 13–16, *ua*) is nearly square, slightly concave, with four equal concave edges. The phyllocyst and its two lateral cæca shine through it in the apical view. The ventral or anterior face (fig. 18, *uv*) has the same square form, but is somewhat longer, and dilated towards the concave basal edge. The dorsal or posterior face of the bract (fig. 17, *ud*) is more concave, and has the form of a bilateral pentagon, which is twice as long as broad. Its odd superior edge is horizontal, and half as long as the two divergent superior lateral edges. These are somewhat longer than the two convergent inferior lateral edges, which meet in the basal apex of the

[1] **9**, p. 60, pl. iv. figs. 2, 3.

pyramidal caudal apophysis. Whilst the superior half of the dorsal face is nearly vertical, square, and concave, its inferior pentagonal half is convex and prominent, directed more dorsally downwards, and bisected by a sagittal crest which becomes obsolete towards the upper half. This crest bears about the middle of its length an odd prominent tooth (figs. 13, 14).

The two-paired lateral faces of the bract (right, fig. 13; left, fig. 14) are hexagonal, square and vertical in their upper half, irregularly hexagonal and more prominent in the lower half. The superior horizontal edge of each lateral face is half as long as the ventral, and one-third as long as the basal and the dorsal edge. The vertical ventral edge is concave. The opposite dorsal edge bears a prominent tooth between its middle and lower thirds, and so also does the obliquely descending basal edge.

The basal or inferior face of the bract is occupied by the square opening of the bracteal cavity (fig. 15, middle portion), and behind this by the triangular ventral face of the caudal apophysis (fig. 18).

The caudal apophysis, which distinguishes the cuboidal bract of *Aglaisma* from the similar bract of *Cuboides* (Pl. XLII.), is a bilateral oblique pyramid, which descends from the prolonged dorsal and basal part of the hydrophyllium. The pyramid is five-sided, directed downwards and dorsalwards up to the apex, which is slightly curved inwards. The five angles of its base are marked by the five above-mentioned teeth, viz., the odd dorsal tooth of the sagittal crest (in the inferior half of the dorsal face), the paired teeth of the latero-dorsal edges, and the paired (somewhat inferior) teeth of the lateral basal edges.

All the edges of the polyhedral transparent bract are elegantly denticulate, and more or less curved.

The bracteal cavity (figs. 13–18, *ui*) opens in *Aglaisma* (as in *Cuboides*) more on the basal or inferior face; whereas in *Amphiroa* and *Sphenoides* the aperture is rather on the ventral or anterior face. It occupies the greater part of the inferior half of the bract, and is obliquely campanulate. The apex of the cavity is directed dorsally.

Phyllocyst (figs. 13–18, *bc*).—The phyllocyst is a small subspherical cavity, placed immediately above the basigaster (*sb*), and gives off four large canals, two odd and two paired, which are comparable to the four radial canals of a bilateral Medusa. The superior odd canal (*cv*), which corresponds to the original ventral canal of the Medusa, ascends vertically near the median line of the dorsal face, and ends above in a spindle-shaped diverticulum which includes an oleocyst (*co*). The inferior odd canal (*cd*) is somewhat longer, also placed in the median plane, and descends obliquely downwards; it runs parallel to the neighbouring dorsal crest, and corresponds to the dorsal radial canal of a Medusa. The two paired lateral canals (*cx* right, *cl* left) are much shorter, wider, and sac-shaped, as in *Cuboides*. They are geniculate and filled by large vacuolate entoderm-cells; their dorsal half is placed nearly horizontally, whilst their ventral half is

curved downwards. Their blind ends are directed towards the ventro-basal angles of the lateral faces.

Siphon (figs. 13, 14, *s*).—The single polypite occupies originally the dorsal half of the bracteal cavity (fig. 13), but, when two gonophores are developed, it becomes placed between them more ventrally (fig. 14). Its thick-walled basigaster (*sb*) is nearly spherical. The spindle-shaped stomach (*sm*) bears eight yellow hepatic stripes. The contractile proboscis (*sr*) opens by an octolobate mouth (*ss*).

Tentacle (figs. 13, 14, *t*).—The single tentacle exhibits the same structure, which is accurately described in the case of *Calpe pentagona* by Kölliker, Leuckart, and others. It arises from the short pedicle of the siphon, between the basigaster and phyllocyst. It bears numerous tentilla, each with a reniform cnidosac and a long terminal filament coiled up spirally in fig. 19. Fig. 20 exhibits its elastic band expanded.

Gonophores (fig. 13, *f*; fig. 14, *hf*).—The bracteal cavity contains sometimes a single gonophore (fig. 13), at other times two or even three gonophores associated, besides some buds of vicarious function. Fig. 14 exhibits a well-developed monoclinic Eudoxia, with a male (*h*) and a female (*f*) gonophore. The sexual manubria of both are club-shaped, and fill about the half of the subumbrellar cavity. The umbrella is in both sexes of the same form, distinctly bilateral, with four paired denticulate edges, prolonged at the basal ostium into four strong triangular pyramidal teeth. The two dorsal teeth are much larger than the two ventral. The apex of the umbrella is a curved horn, and contains the pedicular canal; this gives off at the apex of the subumbrella the four radial canals, as usual.

Family V. Ersæidæ, Haeckel, 1888.

Ersæidæ, Hkl., System der Siphonophoren, 95, p. 33.

Definition.—Calyconectæ monogastricæ, representing a single cormidium, which is composed originally of three persons; a sterile medusome (siphon with tentacle and bract), a sterile special nectophore (without manubrium), and a fertile medusiform gonophore (male or female).

The family Ersæidæ comprises those monogastric Calyconectæ which differ from the preceding Eudoxidæ in the possession of a so-called "special nectophore." Their cormidium is therefore composed not of two, but of three, medusomes or persons of the morphological value of a Medusa. The Ersæidæ, as independent forms, occur much more rarely than the Eudoxidæ. I have observed two genera only, both rather rare, *Ersæa* and *Lilæa*.

The sterile medusome of the Ersæidæ is composed (as in the Eudoxidæ) of three organs—viz., bract (umbrella), siphon (manubrium), and tentacle (cnido-filament); all three

organs possess essentially the same structure as in the preceding Eudoxidæ. The bract occurs only in two forms, one of which (*Lilæa*) is equal to that of *Praya*, or *Lilyopsis*; it is rounded and has a phyllocyst with four radial canals; the other (*Ersæa*) is similar to that of *Muggiæa* or *Diphyes*; it is pointed, cucullate or spathiform, and has a simple phyllocyst, without radial canals.

Gonophores.—The sexual medusomes of the Ersæidæ have the same form and structure as those of the Eudoxidæ; and mainly of those species, where two or more gonophores are produced in a single cormidium (compare above, pp. 100 and 121).

The special nectophore, which is characteristic of the Ersæidæ, and distinguishes them from the Eudoxidæ, has been originally the first gonophore. This has completely lost its manubrium, and has, therefore, given up its sexual function; it has been developed merely as an organ of swimming.

Ontogeny.—On the development of the Ersæidæ, compare above, pp. 100–102.

Synopsis of the Genera of Ersæidæ.

Bract spathiform, with an apex. Phyllocyst simple, without radial canals, . . .	17A. *Ersæa.*
Bract rounded, without apex. Phyllocyst with four radial canals, ...	17B. *Lilæa.*

Genus 17A. *Ersæa*,[1] Eschscholtz, 1829.

Ersæa, Eschscholtz, System der Acalephen, p. 127.

Definition.—Ersæidæ with a campanulate or spathiform bract, divided by a collar constriction into a proximal cowl, with an apical point, and a distal mantle, with a wide ventral fissure. Phyllocyst large, simple, without radial canals. (Cormidia of the genus *Diphyopsis*.)

The genus *Ersæa* was founded by Eschscholtz, in 1829, to include two Atlantic monogastric Diphyidæ, differing from *Eudoxia* in the possession of a special nectophore, which is prominent from the cavity of the bract ("Tubulus suctorius unicus; pars corporis nutritoria cavitate parva natatoria, tubuli instar prominenti instructa"). The two species, however, which Eschscholtz there described (*Ersæa quoyi* and *Ersæa gaimardi*),[2] are too incompletely represented to determine with certainty their position and their connection with any species of *Diphyopsis*. Possibly *Ersæa gaimardi* may be the free cormidium of *Diphyopsis campanulifera*, and *Ersæa bojani* (=*Eudoxia bojani*, Eschscholtz), the cormidium of *Diphyopsis dispar*. I myself observed in 1866, in the Canary Island Lanzerote, numerous free-swimming specimens of the species figured in Pl. XXXIV. as *Ersæa compressa*, and afterwards recognised its ontogenetic connection with *Diphyopsis compressa* (Pl. XXXIII.).

[1] *Ersæa* = ἐρσαία, covered with dew.

[2] 1, p. 128, Taf. xii. figs. 3, 4.

Ersæa, as the monogastric generation of *Diphyopsis*, differs essentially from *Cucullus* as the free Eudoxia of *Diphyes*. The latter never possesses the individual "special nectophore," which is characteristic of the former. This swimming organ must be regarded as the first sterile gonophore, which has lost the manubrium, the muscle-plate of the subumbrella being the more strongly developed.

Ersæa compressa, n. sp. (Pl. XXXIV.).

Habitat.—Tropical and Subtropical Atlantic; Stations, 348, 349, 352, 353, &c. Canary Islands, Lanzerote, December 1866 and January 1867 (Haeckel).

Bract (figs. 9, 10, 11, *b*).—The hydrophyll or bract is in general irregularly conical or campanulate, with a deep fissure along the truncate ventral side; the broad basal or inferior aperture is also obliquely truncate. An annular collar constriction, corresponding to that part of the umbrella which was attached to the stem of *Diphyopsis*, divides the bract into a smaller apical (proximal or superior) part (fig. 11, *bs*) and a larger basal (distal or inferior) part. The latter encloses the siphon and its tentacle, and partly the gonophores, like a mantle, while the former is comparable to the cowl of the mantle. This cowl contains in its solid dorsal half the phyllocyst (*cs*), with a central cavity and a globular oleocyst on the apex (*co*); its ventral half is excavated and originally embraces the stem of siphosome (fig. 9, *a*); the two ventral wings of this cavity overlap one another in the middle part. The length of the bract is 6 to 8 mm., its breadth 3 to 4 mm.

The campanulate mantle, or the larger distal half of the bract, exhibits around its wide basal opening four acute triangular teeth, comparable to the four corners of the original medusa-umbrella. The pair of dorsal teeth is larger and more prominent than the pair of ventral teeth. The two opposite free ventral margins of the bract are smooth.

Siphon (figs. 9, *s*, 10, *s*, 11, *s*).—The polypite or siphon occupies originally the axial part of the bracteal cavity, between the dorsal tentacle (*t*) and the ventral nectophore (*nn*). The basigaster (*sb*) is separated by a sharp pyloric constriction from the stomach, the wall of which exhibits eight longitudinal hepatic ridges. The mouth of the muscular proboscis is surrounded by sixteen short lobes (*so*).

Tentacle (figs. 9, *t*, 10, *t*, 11, *t*).—The long cylindrical tentacle is distinctly articulated, and from the constriction between every two segments arises a thin tentillum or secondary filament (fig. 18). The terminal filament of the latter (*tf*) is about as long as its pedicle (*ts*). The ovate cnidosac placed between them exhibits on its convex side six to eight longitudinal rows of small medial cnidocysts (*km*), on its base two paired groups of large lateral cnidocysts (six to eight spindle-shaped cnidocysts, *kg*, in each), and at the distal part a trilobate group of pyriform cnidocysts (*kp*).

Nectophore (figs. 9, 10, 11, *nn*).—The special nectophore, which contains no manubrium, occupies the ventral fissure of the bracteal cavity, in which only its basal part is enclosed. The umbrella is a slender four-sided pyramid, distinctly bilateral, since the two dorsal edges are stronger, and more prominent at the base, than the two ventral edges. All these edges, and also the quadrangular basal edge, with the four prominent teeth, are elegantly denticulate (fig. 17). The basal and ventral faces of the exumbrella are concave, the dorsal and the two lateral faces convex.

Nectosac.—The peduncular canal, which arises from the base of the phyllocyst, enters through the obliquely truncate top of the nectophore, and divides on the top of the muscular subumbrella (*w*) into four subregular radial canals (*cr*). These unite at the ostium of the umbrella by a circular canal (*cc*) above the broad velum (*v*).

Gonophores (fig. 11, *hm*; figs. 12–14).—The young *Ersæa compressa* possesses, besides the sterile nectophore, only a single gonophore, the older form two or three gonophores. These are usually of the same sex (the cormidia therefore diclinic); but sometimes a male and a female gonophore are present in the same Eudoxia (the cormidium therefore monoclinic). The umbrella (*u*) of the male, as well as of the female gonophores, is slender ovate, with four edges which are smooth in the proximal half, elegantly denticulate in the distal half. They are prolonged over the mouth of the umbrella, and form four prominent triangular teeth, the two dorsal teeth being larger than the two ventral. The subumbrella (*w*) exhibits in the gonophores the same four subregular radial canals, connected by a circular canal, as in the nectophore (figs. 9–11, *nn*).

The male gonophores (fig. 11, *hm*; fig. 12) have in their umbrellar cavity a large spindle-shaped or ovate spermarium (*hm*), with a wide central spadix (*hx*).

The female gonophores (figs. 13, 14) exhibit an ovarium of very variable size (*fm*). Sometimes the entire umbrellar cavity is filled with eggs (fig. 13), whilst, at other times, only a few ova (four in fig. 14) occupy its proximal half.

Genus 17B. *Lilæa*,[1] n. gen.

Definition.—Ersæidæ with a hemispherical or mitriform rounded bract, without sharp edges and without pointed apex. Phyllocyst small, with four radial canals arising from its base. (Cormidia of the genus *Lilyopsis ?*)

The genus *Lilæa* comprises those Ersæidæ which possess a mitriform rounded bract, without sharp edges or apical point. Its form agrees with that of the eudoxomes of *Praya* and *Lilyopsis*. A further resemblance to the latter is given by the fact, that each cormidium possesses a sterile nectophore, the mouth of which bears a circle of rudimentary tentacles and four red pigment-spots (ocelli) at the distal end of the four radial canals. They are very similar to the medusiform special nectophores of *Desmo-*

[1] *Lilæa* (Λίλαια), name of a Naiad.

phyes annectens (Pl. XXX.). The latter agrees also in the formation of the gonophores. Each cormidium possesses, besides the large vigorously swimming special nectophore, a cluster of small gonophores, all either male or female. The umbrella of the male gonophores is more developed than in *Desmophyes*. Among six specimens examined four were males and two females.

I observed half a dozen of these small interesting Ersæidæ, which will be more accurately described on another occasion, living in the Indian Ocean, during my voyage from Aden to Bombay, in November 1881. I suspect that they are the detached cormidia of some species of *Lilyopsis* (Genus 25). They may bear provisionally the name *Lilæa medusina*.

Family VI. MONOPHYIDÆ, Claus, 1874.

Monophyidæ, Claus, 1874, **70**, p. 29.
Sphæronectidæ, Huxley, 1859, **9**, p. 50.

Definition.—Calyconectæ polygastricæ, with a single nectophore at the apex of the long tubular truncus. Cormidia ordinate, eudoxiform, separated by equal free internodes; each siphon with a bract.

The family Monophyidæ comprises a small number of little known polygastric Calyconectæ, which are rather rare, of small size, but very interesting on account of their simple structure. They all possess only a single permanent nectophore, and differ in this character from the nearly allied Diphyidæ, with which they were formerly united.

Eschscholtz, in his fundamental work (1829, **1**, p. 134), described only a single form of Monophyidæ, *Cymba enneagonum*, the free Eudoxia of which is his *Cymba cuboides*. Both forms were discovered in the Straits of Gibraltar by Quoy and Gaimard, who called the first (polygastric) form *Enneagonum hyalinum*,[1] and the second (monogastric) form *Cuboides vitreus*.

A second species of Monophyidæ, inhabiting the Gulf of Trieste, was described in 1844 by Will,[2] under the name *Diphyes kochii*, and in 1851 by Busch,[3] as *Muggiæa pyramidalis*. The same form was afterwards, by combination of both names, called *Muggiæa kochii*, by Chun (**86**, p. 3). He described its metagenesis and development from the monogastric *Eudoxia eschscholtzii*.

Huxley, in his excellent work on Oceanic Hydrozoa (1859, **9**), described not less than four different Monophyidæ, viz. :—

(1) *Sphæronectes köllikeri*, pl. iii. fig. 4.
(2) *Diphyes mitra*, pl. i. fig. 4 (now *Cymbonectes mitra*).
(3) *Diphyes chamissonis*, pl. i. fig. 3 (now *Muggiæa chamissonis*).
(4) *Abyla vogtii*, pl. ii. fig. 3 (now *Cymba vogtii*).

[1] **20**, pl. ii.b, figs. 1–6. [2] **65**, p. 77, Taf. ii. fig. 22. [3] **67**, Taf. iv. figs. 3–6.

Huxley gave an accurate description of the only nectophore observed of these four "Diphyidæ"; he supposed (as did also his predecessors) that the second nectophore had been accidentally lost; it does not, however, exist at all. The genus *Sphæronectes* was rightly regarded by Huxley as the type of a peculiar family—Sphæronectidæ.

During my residence in the Canary Island of Lanzerote (December 1866 to February 1867), I observed four different species of Monophyidæ, viz.:—

(1) *Monophyes hydrorrhoa.*
(2) *Mitrophyes peltifera* (Pl. XXVIII.).
(3) *Muggiæa pyramidalis.*
(4) *Cymba crystallus.*

I was able to examine the complete metagenesis of the latter species, and the development of its Eudoxia, *Cuboides crystallus* (Pls. XLI., XLII.).

A Mediterranean species of *Sphæronectes*, very similar to the Australian form discovered by Huxley, was described in 1874 by Claus, and called *Monophyes gracilis* (**70**, pl. iv.). He observed the development of its Eudoxia, which was formerly described by Gegenbaur as *Diplophysa inermis* (**7**, Taf. xvi. fig. 3). Another Mediterranean Monophyid described by him, *Monophyes irregularis*, may remain the type of this genus. Claus replaced the term Sphæronectidæ of Huxley by the name Monophyidæ, which was accepted as more significant, in opposition to Diphyidæ.

The metagenesis of the two Mediterranean Monophyidæ was afterwards very accurately examined by Chun (**86–88**). Compare his memoirs also for the history of this family.

During my voyage through the Indian Ocean (November 1881 and March 1882) and in Ceylon, I had the opportunity of examining some very interesting new forms of Monophyidæ and their development, viz., *Monophyes princeps* and *Cymbonectes huxleyi* (Pl. XXVII.). Supported by these observations, and by some specimens found in the Challenger collection, I was able to give the following description of Monophyidæ.

Nectophore.—The single nectocalyx of the Monophyidæ exhibits differences in form and structure similar to the first or proximal of the Diphyidæ. Accordingly, I divide the family Monophyidæ into two subfamilies; the first of these, Sphæronectidæ, has a smooth hemispherical or mitriform nectophore, without sharp edges, and is allied to the Prayidæ among the Diphyidæ. The second subfamily, Cymbonectidæ, has a pyramidal nectophore with five prominent edges, and is nearly allied to the Diphyopsidæ and Abylidæ. The single nectophore of the Monophyidæ is relatively large, of a bilateral and quadriradial fundamental form, sometimes symmetrical, at other times asymmetrical. The first nectophore of their larva is replaced by a permanent, often heteromorphous, swimming-bell.

Hydrœcium.—Since the single nectocalyx of the Monophyidæ corresponds to the first apical or proximal nectophore of the Diphyidæ, it possesses a hydrœcium for the reception of the retiring siphosome. This is an open hydrœcial groove, protected by

two overlapping ventral wings, in *Monophyes* and *Cymbonectes* (Pl. XXVII.); it is a conical or campanulate hydrœcial cavity in *Muggiæa* and *Cymba* (Pl. XLI.), a cylindrical canal in *Sphæronectes*. These closed hydrœcia are secondary cavities, produced by concrescence of the two parallel ventral wings, which overlap the hydrœcial groove of the former.

The singular genus *Mitrophyes* (Pl. XXVIII.) is distinguished by the lack of a hydrœcium. It is replaced by an apical scutiform bract, which covers the nectophore and protects the siphosome hidden between them both. The apical bract is probably the remnant of the original primary nectophore.

Nectosac.—The subumbrella in most Monophyidæ occupies the dorsal part of the nectophore, whilst the hydrœcium is placed in its ventral part. The nectosac of *Sphæronectes* and *Mitrophyes* is placed rather basally (as in the ancestral Medusæ), in the other genera rather dorsally. The four radial canals are in the former genera rather regularly disposed, but usually more bilaterally, the ventral canal being shorter, and the dorsal longer than the two paired lateral canals. The ring-canal of the margin, which unites them, is placed above the velum.

Somatocyst.—The acrocyst or somatocyst ("Saftbehälter") in most Monophyidæ is of moderate size, placed in the apical prolongation of the stem; its cavity is narrow, usually filled by large vacuolate entoderm-cells, and its apex mostly contains an oleocyst. It is directed sometimes vertically upwards, at other times more obliquely. Its structure is the same as in the other Calyconectæ (compare above, p. 93).

Siphosome.—The long tubular stem exhibits in the Monophyidæ the same structure as in the Diphyidæ. The median ventral line of the common stem is beset at regular intervals by the cormidia, whose number is very variable. The contracted siphosome may be retracted into the hydrœcium more or less completely.

Cormidia.—Each cormidium (Diphyozooid or Eudoxia) is composed in the Monophyidæ (as in the most Diphyidæ) of two medusomes; the sterile medusome has a bract, a siphon, and a tentacle; the fertile medusome is a gonophore, the umbrella of which has the usual medusoid structure, whilst the manubrium produces the sexual cells (compare above, p. 94).

Siphon and Tentacle exhibit no important differences in the cormidia of the various Monophyidæ, whilst the bracts or hydrophyllia are of very different form and structure, characteristic of the genera (compare above, pp. 95, 96).

Eudoxiæ.—The cormidia of some Monophyidæ arrive at sexual maturity whilst attached to the stem; they remain sessile eudoxomes. This is the case in *Mitrophyes* and *Cymbonectes*, and probably also in *Monophyes*. The cormidia of the three other genera are detached from the stem, and become mature as free-swimming *Eudoxiæ*; those of *Sphæronectes* are described as *Diplophysa*; those of *Muggiæa* as *Cucubalus*, whilst the free Eudoxiæ of *Cymba* belong to *Cuboides*.

Ontogeny.—On the development of the Monophyidæ, compare above, pp. 100–102.

Synopsis of the Genera of Monophyidæ.

I. Subfamily SPHÆRONECTIDÆ. Nectophore hemispherical or mitriform, with rounded surface, without sharp edges.	Hydrœcium a ventral groove of the nectophore, incompletely closed by two overlapping wings,		18. *Monophyes.*
	Hydrœcium a complete cylindrical canal in the ventral wall of the nectophore, with a basal opening,		19. *Sphæronectes.*
	Hydrœcium wanting. Nectophore protected by a cap-shaped dorsal bract; between them is the siphosome,		20. *Mitrophyes.*
II. Subfamily CYMBONECTIDÆ. Nectophore pyramidal, with five prominent sharp edges.	Hydrœcium a ventral groove of the nectophore, incompletely closed by two overlapping wings. Bracts spathiform,		21. *Cymbonectes.*
	Hydrœcium a complete conical or campanulate cavity in the ventral wall of the nectophore.	Bracts of the cormidia conical or spathiform, with a deep ventral fissure,	22. *Muggiæa.*
		Bracts of the cormidia cuboidal, with six square faces and a basal cavity,	23. *Cymba.*

Genus 18. *Monophyes*,[1] Claus, 1874.

Monophyes, Claus, Die Gattung Monophyes, &c., **70**, p. 29.

Definition.—Monophyidæ with a rounded, edgeless, mitriform nectophore, and an open hydrœcial groove on its ventral side; the latter includes the siphosome, which is incompletely protected by two overlapping lateral wings. Bracts mitriform or hemispherical, with rounded surface and a simple phyllocyst.

The genus *Monophyes* was founded in 1874 by Claus for two different Mediterranean species of Calyconectæ, which bear a single mitriform nectophore on the top of the stem. One of these two species, *Monophyes gracilis*, belongs to the following genus *Sphæronectes*, which possesses a closed tubular hydrœcium, open only at the distal end. The other species, *Monophyes irregularis*, may be retained as the type of the present genus; it differs from the former in the bilateral arrangement of the four radial canals of the subumbrella, and mainly in the shape of the hydrœcium, which is not a tubular canal, but an open groove or infundibular cavity.[2] This peculiar character is more developed in two other species, which I have myself observed, *Monophyes princeps*, from the Indian Ocean (Pl. XXVII. figs. 13, 14), and *Monophyes hydrorrhoa*, from the Atlantic Ocean (Canary Islands). The hydrœcial groove extends here along the whole ventral side of the bilateral nectophore, and its two edges are prominent as two free wings, one of which overlaps the other more or less. The Atlantic species (*Monophyes hydrorrhoa*) is very similar to a small Mediterranean form figured in 1885 by Chun, who supposed it to

[1] *Monophyes* = Single animal (μονοφυής); Calyconecta with a single nectophore.

[2] **70**, p. 32, Taf. iv. figs. 16–18.

be the "primary nectophore" of *Monophyes gracilis* (= *Sphæronectes gracilis*), afterwards replaced by a heteromorphous secondary nectophore (87, Taf. ii. fig. 5). But this supposition is not very probable, and I call this form provisionally *Monophyes diptera*, provided that it does not belong to *Cymbonectes* (Genus 21). The eudoxomes of *Monophyes* seem to ripen attached to the stem, and not to form free Eudoxiæ as in *Sphæronectes*.

Monophyes princeps, Haeckel (Pl. XXVII. figs. 13, 14).

Sphæronectes princeps, Hkl., 1887, System der Siphonophoren, p. 34.

Habitat.—Indian Ocean; between the Maldive Islands and Socotra, March 1882 (Haeckel).

Nectophore (fig. 13, lateral view from the left side; fig. 14, transverse section at the middle of the height).—The single nectocalyx is 6 mm. long and 3 mm. broad. Its form is asymmetrical, nearly ovate, with a flat constriction near the base. The surface is perfectly smooth, rounded, and without sharp edges. The transverse section (fig. 13) is subcircular in the upper half, more ovate in the lower half.

The dorsal half of the nectophore, which includes the nectosac (*w*), is of a quite simple ovoid form, bilaterally symmetrical. The ventral half, which includes the siphosome in its hydrœcial groove, is asymmetrical. The thin frontal septum (*nt*), or the vertical transverse jelly-plate, which separates the dorsal nectosac (*w*) from the ventral hydrœcial canal (*ui*), gives off two large parallel and vertical ventral wings, which enclose the latter. The right wing (*nx*) is larger, and overlaps the smaller left wing (*nl*), so that the ventral opening of the hydrœcial groove becomes incompletely closed by the two overlapping wings. The two wings are united at the apical or upper blind end of the groove, whilst they are prolonged into two broad ovate terminal lobes at the basal or lower opening of the groove.

Nectosac (figs. 13, 14, *w*).—The subumbrella of the nectophore occupies its dorsal half (with exception of the apical third) and is subcylindrical, slightly concave on the dorsal, convex on the ventral side, with curved axis. The nectocalycine duct, which arises from the top of the stem, is very short, enters into the ventral wall of the nectosac somewhat below its rounded apex, and divides into four curved radial canals; the ventral of these (*cv*) is shorter, the dorsal (*cd*) longer, than the two paired lateral canals (*cl* left, *cx* right). They are united by a circular canal above the broad velum (*v*).

Hydrœcium (figs. 13, 14, *ui*).—The cavity at the ventral side of the nectophore, which includes the retracted siphosome (*as*), is a flattened canal, the frontal diameter of which is twice as great as the sagittal. It is separated from the neighbouring ventral side of the nectosac (*w*) by the thin frontal septum. The hydrœcial canal is blind at

its apex, where the top of the stem is inserted; it is protected at its ventral side by the two overlapping wings, and opens below by a dilated basal mouth, whence issues the siphosome.

Somatocyst (*cs*).—The uppermost rounded apical part of the nectophore is occupied by an ovate somatocyst, which arises, as the apical prolongation of the stem, between the apical ends of the nectosac and the hydrœcial canal. It is filled with large vacuolate entoderm cells, and contains in its rounded apex a globular oleocyst (*co*).

The somatocyst of the Indian *Monophyes princeps* is wanting in the Atlantic *Monophyes hydrorrhoa*, and the similar Mediterranean *Monophyes diptera* (Chun, **87**, Taf. ii. fig. 5). These two species represent an older phylogenetic state, since the two parallel ventral wings of the nectophore are separated in its whole length, and not united in the apical third; this difference explains the absence of the somatocyst in them.

Siphosome (figs. 13, 14, *as*).—The common stem, retracted into the hydrœcial canal (*ui*), was in the specimen observed rather short (probably broken off), and bore (besides numerous small buds) not more than five or six immature eudoxomes. Each eudoxome had a hemispherical bract and, protected by it, a siphon with its tentacle, and a small ovate gonophore; the form and structure of these parts, which I could not sufficiently examine, seems to agree with those of *Monophyes irregularis*.

Genus 19. *Sphæronectes*,[1] Huxley, 1859.

Sphæronectes, Huxley, The Oceanic Hydrozoa, p. 50.

Definition.—Monophyidæ with a rounded, edgeless, subspherical nectophore, and a complete tubular hydrœcium on its ventral side; the latter includes the siphosome. Bracts mitriform or subspherical, with rounded surface and a simple phyllocyst (*Diplophysa*, Genus 10).

The genus *Sphæronectes* was founded in 1859 by Huxley for an Australian Monophyid, *Sphæronectes köllikeri*,[2] which was remarkable for a single subspherical nectophore with a tubular hydrœcium. Another closely allied Mediterranean species was described fifteen years later by Claus under the name *Monophyes gracilis* (**70**, p. 29, fig. 8). The same author there gave the description of a similar third Monophyid under the name *Monophyes irregularis* (*ibid.*, p. 32, figs. 16, 17). We retain the generic name *Monophyes* for this latter species, whilst the two former are better placed in Huxley's original genus, *Sphæronectes*. The first-described Australian species, *Sphæronectes köllikeri*, differs from the Mediterranean *Sphæronectes gracilis* in the flatter, more depressed nectophore, and the subhorizontal, not geniculate somatocyst. A specimen of *Sphæronectes köllikeri* was found by me in the Challenger collection, taken from the surface of the Tropical Pacific at Station 274. The same bottle con-

[1] *Sphæronectes* = Swimming sphere (σφαῖρα, νήκτης).

[2] 9, p. 50, pl. iii. fig. 4.

tained a few detached Eudoxiæ of this species, which fully developed represent the monogastric *Diplophysa köllikeri*, Haeckel.

Sphæronectes may be derived from *Monophyes* by concrescence of the two parallel crests or wings, which arise from the ventral side of the nectophore. The hydrœcial groove of the latter becomes converted by this process into a closed tubular hydrœcium, which includes the siphosome. The cormidia, which are attached to the common stem at regular intervals, possess a subspherical bract with a simple vertical phyllocyst, and detached from the stem represent the genus *Diplophysa* (compare p. 107).

Genus 20. *Mitrophyes*,[1] Haeckel, 1888.

Mitrophyes, Hkl., System der Siphonophoren, p. 34.

Definition.—Monophyidæ with a rounded, edgeless, hemispherical or mitriform nectophore, without a true hydrœcium. Trunk free between the exumbrella of the nectophore, and a scutiform or cap-shaped bract, depending from the junction of these two pieces. Bracts spathiform or semi-ovate, without phyllocyst.

The genus *Mitrophyes* was founded by me for an Atlantic Monophyid, which I observed living in the Canary Sea, in January 1867. I observed there two complete specimens, a male and a female. A third specimen (female) was found in the Challenger collection, among other pelagic animals from Station 352. The latter specimen was well enough preserved to enable me to identify it with the former.

Mitrophyes differs from all other Monophyidæ in the possession of a peculiar bract, which covers the single nectophore like a shield or cap, and in the absence of a hydrœcium, the trunk depending freely between those two pieces and arising from their junction. It may be compared to a *Prâya* or a similar Diphyid, the first nectophore of which is rudimentary and transformed into a bract.

Mitrophyes peltifera, n. sp. (Pl. XXVIII.).

Habitat.—Tropical and Northern Atlantic, Station 352; April 13, 1876; lat. 10° 55′ N., long. 17° 46′ W. Surface.

Canary Islands, Lanzerote, January 1867 (Haeckel).

Nectophore.—The single large nectophore is nearly hemispherical, somewhat oblique, its nectosac being higher in the ventral than in the dorsal half; it is 6 to 8 mm. long, 4 to 5 mm. high. The voluminous jelly-mantle of the umbrella is twice as thick in the dorsal part as in the ventral. The equatorial diameter of the smooth rounded exumbrella is nearly twice as great as that of the subumbrella, and as the height of the nectophore.

[1] *Mitrophyes* = Mitrophorous, animal provided with a mitre, μίτρα, φυής.

The obliquely egg-shaped subumbrella is much more vaulted in the ventral than in the dorsal half; the diameter of its aperture is about equal to its height. The velum (figs. 1, *v*, 2, *v*) is small. The four radial canals of the subumbrella are arranged symmetrically; the dorsal canal (figs. 1, 2, *cd*) is shorter, the ventral (*cv*) longer than the two lateral canals (*cx* right, *cl* left). The apical canal (fig. 7, *cn*), which arises from their proximal junction, is short, and passes obliquely through the jelly substance of the top in ventral direction to the somatocyst (*cs*).

Apical Bract (figs. 1, *b*, 2, *b*, 7 *b*).—The peculiar organ, which we call the apical bract, distinguishes at once *Mitrophyes* from all other Monophyidæ, and from all Calyconectæ in general. It covers the exumbrella of the nectophore in the same manner as a cap covers the head of a man. The bract is a circular concave-convex shield, the diameter of which nearly equals that of the subjacent nectophore.

Its morphological signification is difficult to make out; it may be nothing other than the reduced umbrella of a medusome, which has lost all its other parts; but it may also be the remnant of the primary nectophore, the place of which is taken by the permanent nectophore afterwards developed. These two pieces are connected by a narrow short pedicle (figs. 2, 7) which is probably the uppermost part of the original trunk. The jelly substance of the bract is rather thin in the peripheral, thicker in its central part, and includes here three short blind radial canals, a longer dorsal (fig. 1, *cb*) and two smaller lateral canals; from their junction arises a short bracteal canal (fig. 7, *cb*) which passes through the pedicle to the somatocyst (*cs*).

Somatocyst (figs. 1, 2, 7, *cs*).—The somatocyst, or the coryphal cavity of the stem, is a slender conical canal, placed nearly horizontally in the gelatinous umbrella of the nectophore, in its sagittal plane, and directed towards the dorsal side. Its direct continuation towards the ventral side is the axial canal of the trunk. Its proximal apex is closed. From its distal base arise two lateral branches nearly opposite; proximally the peduncular canal of the bract (fig. 7, *cb*), and distally the peduncular canal of the nectophore (fig. 7, *cn*).

Hydrœcium.—Mitrophyes does not possess a distinct hydrœcium, but it has a very small cavity, which may be considered as the rudimentary homologue of such a "funnel cavity" (figs. 1, 7, *ui*). This rudiment of a hydrœcium is placed nearly in the apex of the nectophore, and represents a very small funnel-shaped foveola of its exumbrella, which surrounds the origin of the free trunk (*α*).

Siphosome (figs. 1, 2, 7, *α*).—The common trunk or stem of the siphosome in the expanded state (fig. 1) is a very long thin cylindrical tube, attaining a length of 20 to 30 mm. The internodes between the ordinate cormidia are twice as long as these. In the contracted state (fig. 2) the internodes disappear, and the convoluted stem becomes hidden between the nectophore and bract. The number of the cormidia in the largest specimen observed was between thirty and forty.

Cormidia (figs. 3, 5).—The cormidia, or the single "groups of persons," disposed regularly in metameric order, are sessile eudoxomes, the sexual organs becoming ripe on the stem. There are no free Eudoxiæ developed. In two of the three observed specimens all the eudoxomes were female (figs. 3, 4), in the third specimen male (figs. 5, 6). *Mitrophyes*, therefore, is one of the rare dioecious Siphonophoræ. Each eudoxome is composed of two medusomes, one sterile (siphon with tentacle and bract) and one fertile (the gonophore).

Lateral Bracts (figs. 3, *b*, 5, *b*).—The bract of each cormidium is an oblongish scale, nearly of the form of a bisected egg. Its proximal part is rounded and attached to the stem (*a*), its distal part is obtusely pointed. The convex umbrella is smooth. Its sub-umbrellar cavity covers the included siphon and gonophore only partly. There is no phyllocyst or bracteal canal.

Siphon (figs. 3, *s*, 5, *s*).—The siphon of each cormidium is placed between bract (dorsally) and gonophore (ventrally). Its pedicle is very short, the basigaster (*sb*) very thickened, nearly spheroidal, with a dense accumulation of cnidocysts. The stomach (*sm*) is ovate, thick-walled, and includes numerous scattered large cnidocysts (*kc*) in the exoderm; its entoderm possesses hepatic striæ. The proboscis (*sr*) is very muscular, cylindrical, with a simple circular mouth-opening (*so*).

Tentacle (figs. 1, 3, 5, *t*).—The single long tentacle which arises from the pedicle of each siphon bears a great number of tentilla. The cnidosac of each tentillum (fig. 8) is kidney-shaped, and bears at its proximal base only two pairs of large ovate cnidocysts (*kg*). The terminal filament is about as long as the pedicle of the tentillum (figs. 5, 8).

Gonophores (figs. 3, *f*, 4, female; figs. 5, *h*, 6, male).—Each cormidium bears only a single gonophore without accessory sexual bells. They possess the usual shape of medusoid gonophores in Calyconectæ, and are about as large as the siphon. The spermaria (figs. 5, 6, *hs*) are more longish than the ovaria (figs. 3, *o*, 4). The umbrella possesses in both sexes four regular radial canals, which are united by a ring-canal at the basal ostium (*uo*).

Genus 21. *Cymbonectes*,[1] Haeckel, 1888.

Cymbonectes, Hkl., System der Siphonophoren, p. 34.

Definition.—Monophyidæ with an angular, pyramidal nectophore, and an open hydrœcial groove on its ventral side; the latter includes the siphosome, which is incompletely protected by two overlapping lateral wings. Bracts spathiform, with an open ventral fissure, and a simple ovate phyllocyst.

The genus *Cymbonectes* has hitherto been known by a single species only, described in 1859 by Huxley as *Diphyes mitra*, and taken only once in the Indian Ocean.[2]

[1] *Cymbonectes*=Swimming boat, κυμβονήκτης.

[2] 9, p. 36, pl. i. fig. 4.

That author observed only a single nectocalyx, and supposed that it might be a young and imperfect *Diphyes*. But I find the same form in different bottles from the Challenger, taken in the Pacific, and also in the collection of Captain Rabbe. One nectophore only (the first or proximal) is always present, whilst there is no trace of a second or distal nectophore. I am therefore convinced that this form is a true Monophyid, not a Diphyid, and this the more as the peculiar character of this group is yet more distinct in another Indian species, *Cymbonectes huxleyi;* I observed this species, described in the following pages, during my stay in Ceylon. A third species, *Cymbonectes cymba*, inhabits the Atlantic Ocean, and will be described afterwards.

Cymbonectes has no complete hydrœcium, but an open infundibular groove on the ventral side of its nectosac; it agrees in this respect with the genus *Monophyes* (*sensu stricto*, compare p. 128), but it differs from this in the pyramidal form of its angular nectophore.

Whilst in Belligemma I succeeded in observing the development of the fertilized egg of *Cymbonectes huxleyi;* it is very similar to that of *Galeolaria aurantiaca*, described by Metschnikoff (**84**, Taf. vi., vii.). The four most important stages of it are figured in Pl. XXVII. figs. 9–12.

Cymbonectes huxleyi, n. sp. (Pl. XXVII. figs. 1–12).

Habitat.—Indian Ocean; Belligemma, Ceylon, December 1881 (Haeckel).

Nectophore (fig. 1, lateral view from the right side; fig. 2, dorsal view; fig. 3, ventral view; fig. 4, transverse section through the middle part).—The single nectocalyx is helmet-shaped or slenderly campanulate, 6 to 7 mm. long, 2 to 3 mm. broad; it is somewhat broader in the upper than in the lower half. The exumbrella has five prominent, elegantly denticulate edges which unite above in the pointed apex, and end below in the median crests of five triangular teeth surrounding the basal mouth.

The five edges of the nectophore are arranged as in *Diphyes*, one odd running along the dorsal median line (near the nectosac), two lateral corresponding to the two lateral canals of the latter, and two ventral forming the edges of the hydrœcial canal. From the base of these latter arise in the lower half of the nectophore two broad triangular wings, the larger left of which overlaps the other and thus incompletely closes the hydrœcial groove (fig. 4); the free edges of these wings are strongly dentate (fig. 3). The bases of the wings are continued above the basal ostium of the nectophore, and here form on its ventral side two broad ovate basal lobes with elegantly denticulate edges. These lobes support the siphosome proceeding from the basal mouth of the hydrœcial canal.

Nectosac (fig. 2, *w*).—The subumbrellar cavity is ovate, twice as long as broad, and

broader in the upper than in the lower half. It occupies the two distal thirds of the nectophore, whilst its proximal third is taken by the somatocyst (*cs*). Its ventral side is separated by a thin frontal septum from the adjacent hydrœcium. The basal mouth of the nectosac is obliquely truncate and surrounded by five strong triangular teeth, the distal ends of the five exumbrellar crests. The two ventral teeth (as the terminal lobes of the two hydrœcial plates) are about four times as large as the three other teeth, which form an odd dorsal point and two paired lateral points.

Canals of the Nectosac.—The nectocalycine duct, which arises from the top of the stem (*aa*), descends nearly to the middle of the dorsal median line of the subumbrella, and divides here into four radial canals, two odd and two paired. The odd ventral canal (*cv*) is the shortest, and descends immediately straight to the ostium of the nectosac. The odd dorsal canal (*cd*) is the longest; it ascends, in the dorsal median line, to the apical top of the nectosac, and then descends downwards along its whole ventral median line. The two paired lateral canals (right *cx*, and left *cl*) are intermediate in length between the former and the latter, and have a strongly bent course. They run firstly ascending towards the dorsal side, form in the upper half of the nectosac a nearly circular loop, and then are turned ventrally and downwards. The four radial canals are united at the ostium of the nectosac by a circular canal, which embraces the velum (*v*).

Hydrœcium (figs. 1–4, *ui*).—The funnel-cavity of the nectophore, into which the contracted siphosome may be partly retracted, is a long, nearly cylindrical and slightly bent canal, which occupies the two distal thirds of the ventral half of the umbrella. It is separated from the dorsally adjacent nectosac by a thin frontal septum, and incompletely closed on its ventral side by the two triangular ventral wings of the exumbrella overlapping one another (figs. 3, 4, *nx* right, *nl* left). Its basal ostium is protected at the dorsal side by the two terminal lobes of the ventral crest. The apex of the hydrœcial canal touches the base of the somatocyst.

Somatocyst (*cs*).—The axial canal of the tubular stem is prolonged above its apex into a pyriform cavity, nearly filled up by large vacuolated entoderm-cells. This is the pyriform somatocyst, which encloses in its dilated uppermost part a hydrostatic oil-globule (*co*). It occupies the uppermost or apical third of the nectophore, and is far prominent over the top of the nectosac. It is twice as long as broad, and nearly one-third as long as the nectophore.

Siphosome.—The common tubular stem, which arises in the closed apex of the hydrœcium, at the base of the somatocyst, proceeds through the basal ostium of the former to a considerable length. It is beset by a series of numerous buds in the upper part, and eight to twelve fully-developed cormidia in the lower part. These are alternating male and female, separated by equal free internodes (fig. 1).

Cormidia (figs. 6, 7).—Each cormidium, or "group of individuals," is a eudoxome, composed of two medusomes, a sterile and a fertile. The sterile Medusa exhibits a

spathiform bract, and hidden in its cavity a siphon with its tentacle. The fertile medusome, placed at the ventral side of the former, is a medusiform gonophore, either male or female.

Bract (figs. 5, 6, *b*).—The protecting rudimentary umbrella or hydrophyllium is similar to that of *Diphyes*, spathiform, or irregularly conical, with a deep ventral fissure, and an obliquely truncate base. Its structureless jelly-plate is very thin in the lower half, thick in the upper half, which encloses a large pyriform phyllocyst. This contains large vacuolate entoderm cells, and an oil-globule in its apex. The truncate base of the bract has four corners, two ventral smaller and two dorsal larger triangular lobes.

Siphon (figs. 5–7, *s*).—The single polypite which is attached on the top of the sub-umbrellar cavity of the bract has the formation usual in the Calyconectæ, a short pedicle, an ovate basigaster with very thick exoderm, full of cnidocysts (*sb*), a utricular stomach with thick entoderm (*sm*), and a very protractile proboscis (*sr*); the distal mouth-opening of the latter may be expanded in form of a circular suctorial disc (fig. 5, *ss*).

Tentacle (figs. 5–7, *t*).—The single tentacle which arises from the pedicle of the siphon is of medium size, and bears a row of ten to fifteen or more tentilla. Each of these lateral branches bears upon its club-shaped pedicle a reniform cnidosac (fig. 8, *km*). This includes on its convex side about four to six longitudinal rows of smaller paliform cnidocysts, and at its base, on both sides, three very large ensiform cnidocysts; the terminal filament (*tf*) is usually coiled up, and armed at the distal end with a hemispherical group of pyriform cnidocysts, provided with long cnidocils (*kp*).

Gonophores (figs. 5, 6).—The sexual medusoids alternate regularly in the cormidia, so that each two neighbouring ones form together a diclinic pair. The male eudoxomes (fig. 6) are nearly of the same shape as the female (fig. 5). Each gonophore is an ovate or club-shaped sac, placed at the ventral side of the siphon. The rudimentary umbrella, which possesses the usual four radial canals, and the uniting marginal canal, embraces closely the manubrium. The spadix or central canal is large in the spermaria (fig. 6, *hx*), small or rudimentary in the ovaria (fig. 5, *f*).

Genus 22. *Muggiæa*,[1] Busch, 1851.

Muggiæa, Busch, Wirbellose Seethiere, &c., **67**, p. 48.

Definition.—Monophyidæ with an angular pyramidal nectophore and a complete infundibular hydrœcium on its ventral side. Bracts spathiform or conical, with a deep ventral groove, a bevelled basal face, and a simple ovate phyllocyst.

The genus *Muggiæa* was founded in 1851 by Busch (**67**, p. 48) for a Mediterranean Monophyid, which Will had figured seven years before under the name *Diphyes kochii* (**65**, p. 77, Taf. ii. fig. 22). The identity of these two forms was demonstrated in 1882

[1] *Muggiæa*=Inhabitant of the port of Muggia, near Trieste.

by Chun, who called it *Muggiæa kochii* (86, p. 1157, Taf. xvii. fig. 2). Chun demonstrated that this polygastric Calyconecta is a true Monophyid, and that the cormidia, arising from the common stem, become detached and sexually developed as the free monogastric generation, which was described by Busch under the name *Eudoxia eschscholtzii*.[1] Chun also gave the full description of its ontogeny, and found that the larva, arising from the fertilised egg of *Eudoxia eschscholtzii*, does not possess the pentagonal pyramidal nectophore of *Muggiæa*, but the edgeless campanulate nectophore of *Monophyes*; the latter afterwards buds from the base of the former, and remains when the former is detached. Chun supposed, therefore, that three different generations should be distinguished in this species—(1) *Monophyes pyramidalis* (85, fig. 1), (2) *Muggiæa kochii* (fig. 2), and (3) *Eudoxia eschscholtzii* (fig. 3). I cannot agree with this opinion, but I regard the first form (fig. 1) only as the larva of the second (fig. 2). The primary edgeless nectophore of *Monophyes* is only a provisional larval organ, and the fact that it is afterwards replaced by the secondary five-edged pyramidal nectophore of *Muggiæa* may be explained by the fundamental law of biogeny — by the hypothesis that *Monophyes* is the original ancestral form of *Muggiæa*.

The mature Eudoxia of *Muggiæa* is very similar to the monogastric genus *Cucullus*, the Eudoxia of *Diphyes*. It differs in the rounded and edgeless surface of the conical or spathiform bract, which has three or five edges in *Cucullus*. In respect of this difference, the name *Cucubalus* (given in 1824 by Quoy and Gaimard, 24) may be retained for it. The spathiform bract is obliquely conical, with a deep ventral groove, rounded dorsal convexity, pointed apex, and simple phyllocyst (compare above, Genus 11B, p. 109). The free Eudoxia of the Mediterranean *Muggiæa kochii* may, therefore, bear the name *Cucubalus eschscholtzii*.

A second species, slightly differing from the Mediterranean one, was observed by me in the Canary Island Lanzerote, and may retain the name *Muggiæa pyramidalis*; it differs from the former mainly in the size of the conical hydrœcium, the top of which attains half the length of the nectosac. The free Eudoxia of this Atlantic species has a conical bract, with a blunt apex and an ovate larger phyllocyst; it may be called *Cucubalus pyramidalis*.

A third species of *Muggiæa* is probably the Tropical Pacific form, described by Huxley in 1859 as *Diphyes chamissonis*.[2] It agrees with *Muggiæa pyramidalis* in the size of the high hydrœcium, but differs from this Atlantic and from the Mediterranean species in the more campanulate form of the nectophore, the denticulate shape of its edges, and the stronger teeth of its mouth. The free Eudoxia of this Pacific species may, perhaps, be *Cucubalus cordiformis* of Quoy and Gaimard.[3] *Muggiæa* differs from the preceding

[1] 67, p. 33, Taf. iv. figs. 7–10; Taf. v. figs. 1–9.

[2] 9, p. 36, pl. i. fig. 3.

[3] 2, p. 94, pl. iv. figs. 24–27; 24, pl. vi. fig. 1.

Cymbonectes mainly in the complete infundibular cavity of the hydrœcium, and, therefore, bears to it the same relation that *Sphæronectes* exhibits to *Monophyes*.

Genus 23. *Cymba*,[1] Eschscholtz, 1829.

Cymba, Esch., System der Acalephen, p. 133.

Definition.—Monophyidæ with an angular, pyramidal nectophore, and a complete infundibular hydrœcium on its ventral side. Bracts cuboidal, with six quadrangular faces, and two lateral lobes arising from the base of the phyllocyst.

The genus *Cymba* of Eschscholtz comprised in the system of its founder three different species, the first of which (*Cymba sagittata*) belongs to a different genus of Calyconectæ (it is an Abylid). The second species, which I retain as the type of our genus, is the Mediterranean *Cymba enneagonum*, Esch. (= *Enneagonum hyalinum*, Quoy et Gaimard, **2**, pl. v. figs. 1–6). The monogastric generation, or the Eudoxia of this polygastric Monophyid, is the third species of Eschscholtz, *Cymba cuboides* (= *Cuboides vitreus*, Quoy et Gaimard, not Huxley!).

Different from this typical and oldest known Mediterranean form is a second, Australian, species, which Huxley described very accurately in 1859, under the name *Abyla vogtii* (**9**, fig. 46, pl. ii. fig. 3). He rightly suspected that his *Cuboides vitreus* (not identical with that of Quoy et Gaimard) might be the detached Eudoxia of the former; he found both together at the same place on the south coast of New Guinea.

A third species, *Cymba nacella*, was found by me in 1881 in the Indian Ocean, and will be described on another occasion. It is more similar to *Cymba vogtii* (= *Abyla vogtii*, Huxley) than to the two western species. Its Eudoxia is *Cuboides nacella*.

The fourth species, here described as *Cymba crystallus*, was observed living by me in the Canary Islands in 1867, and from these living specimens are taken the figures on Pls. XLI. and XLII. (compare above, p. 111). The same form occurred in the Challenger collection, having been taken in the Guinea current at Station 348.

The remarkable cuboidal form of the bracts, and the bilobate horizontal diverticulum of their phyllocyst, distinguishes *Cymba* at once from all other Calyconectæ.

Cymba crystallus, n. sp. (Pls. XLI., XLII.).

Abyla crystallus, Haeckel, 1867, MS. Canar.

Habitat.—Tropical and Subtropical Atlantic, Station 348; April 9, 1876; lat. 3° 10′ N., long. 14° 51′ W. Surface.

Canary Islands, Lanzerote, February 1867 (Haeckel).

[1] *Cymba*=Boat, κύμβη.

Nectophore (fig. 1, basal view; fig. 2, apical view; fig. 3, dorsal view; fig. 4, ventral view; fig. 5, lateral view from the left side).—The single nectophore (or the apical nectocalyx) has a diameter of 10 to 15 mm., and a complicated polyhedral form. In that position which is regarded as the normal in figs. 3, 4, and 5, the two parallel axes of the nectosac and of the hydrœcium stand vertically. The umbrella of the nectophore appears composed of a quadrilateral pyramid in the apical half, and of a polygonal prism in the basal half.

The apical view of the nectophore (fig. 2) exhibits a rather regular quadrilateral pyramid. Its four perradial edges (the dorsal *nd*, the opposite ventral or coryphal *nk*, and the two lateral, right and left) meet in the central apex of the pyramid at right angles. The four faces separated by them are irregularly rhombic, the two dorsal (left *ud'*, and right *ud''*) and the two apici-ventral faces (left *ua'*, and right *ua''*). Each of these four faces is slightly concave, and in the middle between each two pyramid edges is prolonged into a descending pyramidal apophysis; these four basal apophyses alternate regularly with the four pyramid edges, and are of course interradial.

The basal view of the nectophore (fig. 1) shows that these four interradial basal apophyses are three-sided pyramidal, and that their inferior crests or basal edges are directed radially towards the centre of the basal face. The centripetal end of the basal edge of the two dorsal apophyses passes over directly into the two lateral teeth of the mouth of the nectosac, whereas the centripetal end of the basal edge of the two ventral apophyses finally passes over into the two smaller dorsal teeth of the mouth of the hydrœcium. The four basal faces of the nectophore, which are separated by those four interradial basal crests, are also concave, and have a bilateral-rhombic, or, strictly speaking, pentagonal form. The ventral basal face (*uv*) is somewhat smaller than the dorsal basal face (*ug*), and the two pentagonal lateral basal faces are intermediate between them.

The ventral view of the nectophore (fig. 4) therefore exhibits the smaller ventral basal face (*uv*) surrounded by four larger faces (fore-shortened); the two ventral basal faces (*ux* right, *ul* left) and the two ventral apical faces (*ua''* right, *ua'* left). The somatocyst (*cs*), with its apical oleophore (*co*), and beyond it the hydrœcium (*ui*), with the included siphosome, appear through the ventral wall of the nectophore in this view (fig. 4). The basal opening of the hydrœcium (*ui*) is surrounded by four serrate triangular teeth, two smaller ventral and two larger dorsal.

The dorsal view of the nectophore (fig. 3) exhibits the two large quadrilateral dorsal apical faces (*ud'* left, and *ud''* right), and beyond them the pentagonal dorsal basal face of the nectosac may be seen through the dorsal wall of the nectophore, and above it the oleocyst (fig. 3, *co*).

Nectosac (fig. 6, *w*, lateral view, right side; fig. 5, lateral view, left side; fig. 3, *w*, dorsal view; fig. 2, *w*, apical view; fig. 1, *w*, and 7, basal view).—The nectosac, or the muscular subumbrella of the nectophore, includes a slenderly ovate cavity, which in the

contracted state is three to four times as high as broad. Its height equals half the height of the complete nectophore. Its dorsal face is more convexly vaulted than the ventral, which is nearly in contact with the dorsal wall of the hydrœcium. The canal of the nectophore (fig. 6), which arises from the constriction between somatocyst (*cs*) and hydrœcium (*ui*), descends nearly vertically to the centre of the ventral median line of the nectosac, and here gives off the four radial canals, which have very different lengths. The shortest is the ventral canal of the nectosac (fig. 6, *cv*); it extends only through the basal half of the nectosac. The longest, on the contrary, is the opposite dorsal canal (*cd*); it runs from the basal circular canal (*cc*) along the whole dorsal side (in the dorsal median line of the nectosac), and then from its top downwards through the apical half of the ventral line. The two symmetrical lateral canals (*cx* right, and *cl* left) are equal and form an S-shaped loop; they ascend from the basal circular canal (*cc*) in the dorsal half of the nectosac vertically, send off into its apical third a slender cæcal sac (*cy*), and then descend in the ventral half, meeting each other and the two other canals near to the centre of the ventral line.

The mouth of the nectosac (figs. 1, *no*, and 7, *no*, basal view; fig. 8, *no*, lateral view from the right side) is surrounded by a broad velum (*v*) and armed with five serrate teeth of nearly equal size, the odd dorsal tooth (fig. 8, *nd*) is perradial; the two paired dorso-lateral teeth (n^1 left, n^2 right) give off the two dorsal basal crests of the nectophore; finally, the two paired ventro-lateral teeth (fig. 8, n^3 left, n^4 right) may be regarded as separated branches of a forked (originally odd) ventral tooth.

Hydrœcium (figs. 1 and 7, *ui*, basal view; fig. 2, *ui*, apical view; fig. 4, *ui*, ventral view; fig. 5, *ui*, lateral view from the left side; fig. 6, *ui*, from the right side).—The hydrœcium or the funnel cavity of the umbrella completely includes the retracted siphosome; it is slenderly campanulate or nearly cylindrical, and about as large as the nectosac, which is placed at its dorsal side. The vertical main axes of these two organs are nearly parallel; but the apical half only of the hydrœcium is in immediate contact with the basal half of the nectophore, whilst the basal half of the former projects freely beyond in the form of a short and wide campanulate tube (figs. 5, 7, 8, *ui*). The basal mouth of the latter is the lowermost base of the entire nectophore, and is armed with two pairs of serrate teeth, the two teeth of the dorsal pair being larger than those of the ventral pair (figs. 7, 8).

Somatocyst (fig. 4, *cs*, ventral view; figs. 5, 6, *cs*, lateral view).—The somatocyst or the coryphal cavity is ovate or spindle-shaped, about half as long and broad as the hydrœcium. It is placed at the apex of the latter, in the apical prolongation of its vertical main axis, and is nearly filled with large polyhedral entoderm cells. Its dorsal wall is in contact with the upper half of the ventral wall of the nectosac. Its apex bears a vertical oleocyst, containing a large ovate oil-bubble, about one-third as long and broad as the somatocyst.

Siphosome (figs. 4–6, *i*).—The common trunk bears in its upper part very numerous buds of cormidia (*i*), in its lower part ten to twelve or more well-developed eudoxomes. These are soon detached from the stem and swim about as free Eudoxiæ of the special form represented in Pl. XLII. as *Cuboides crystallus* (compare their description above, p. 112, Genus 13). When fully contracted the entire siphosome, with all cormidia, is hidden in the hydrœcium (figs. 4–6).

Family VII. DIPHYIDÆ, Eschscholtz, 1829 (*sensu restricto*).

Diphyidæ, Esch., System der Acalephen, 1, p. 122.

Definition:—Calyconectæ polygastricæ, with two nectophores at the apex of the long tubular trunk. Cormidia ordinate, eudoxiform, separated by equal free internodes, each siphon with a bract.

The family Diphyidæ, as defined in my system, comprises only those polygastric Calyconectæ which bear two permanent nectophores on the top of the stem. I exclude, therefore, those forms, formerly united with them, which possess only a single nectophore (Monophyidæ). I exclude, further, on practical grounds, the monogastric independent forms, which are connected with the Diphyidæ by metagenesis, the so-called Diphyozooids, the families (IV. and V.) Eudoxidæ and Ersæidæ. The Diphyidæ are very common in all the seas of the world, far more frequent than all other Siphonophoræ, and richer in different species than the other Calyconectæ.

The first Diphyid was described in 1804 by Bory under the name *Biphora bipartita* (**13**, vol. i. p. 134). Cuvier founded for it the genus *Diphyes* (in 1817, **91**), and Chamisso figured the same as *Diphyes dispar* (**16**, p. 365, Tab. xxxiii. fig. 4).

The naturalists of the "Astrolabe," Quoy and Gaimard, discovered in 1826, in the Straits of Gibraltar, a greater number of Diphyidæ, and distinguished in this family six different genera:—1. *Diphyes* (*campanulifera*); 2. *Calpe* (*pentagona*); 3. *Abyla* (*trigona*); 4. *Cymba* (*sagittata*); 5. *Enneagonum* (*hyalinum*); and 6. *Cuboides* (*vitreus*) (**20**). These and some other Diphyidæ were described and figured by the same authors in 1833 in the Zoophytes de l'Astrolabe (**2**, pp. 81–106) as fifteen different species of the genus *Diphyes*, nearly every species of which is now the type of a special genus.

Eschscholtz (**1**, p. 122) gave the first accurate description and a better systematic arrangement of the Diphyidæ; they form, in his System der Acalephen, the first of the three large families of Siphonophoræ. He distinguished six genera; three of these (*Eudoxia, Ersæa, Aglaisma*) are monogastric, and form now our family Eudoxidæ (p. 103); the three others (*Abyla, Cymba, Diphyes*) are polygastric; one of these (*Cymba*) is according to my observations a Monophyid, so that only *Diphyes* and *Abyla* remain as types of true Diphyidæ.

Blainville, in his Actinologie (**24**, pp. 125–140), and Lesson, in his Acalephes (**3**, pp. 425–465), collected the scattered descriptions and figures of the older observers, and distinguished a greater number of genera, but without any clear anatomical understanding and without critical judgement.

The excellent naturalists, who, in the sixth decade of our century (1853 to 1859), did so much for the anatomical knowledge of Siphonophoræ, gave also the first accurate description of the typical Diphyidæ, mainly *Diphyes* and *Abyla* (**4–10**). Kölliker (**4**, Tab. ix.–xi.) gave an excellent description of three Mediterranean types—*Praya diphyes*, *Diphyes sieboldii*, and *Abyla pentagona*. Vogt (**6**, Tab. xvi.–xxi.) gave beautiful drawings of the same forms, and also of *Galeolaria aurantiaca*. But the greatest progress in the knowledge of Diphyidæ, mainly regarding their development and connection with Eudoxidæ, was made by Gegenbaur (**7** and **10**) and by Leuckart (**5** and **8**). The former described, too, a greater number of new species (of *Praya*, *Diphyes*, and *Abyla*, **10**).

The most complete anatomical and systematic description of the polygastric Diphyidæ, and of their offspring, the monogastric Eudoxidæ, as also the best and fullest account of the whole family up to our days, was given in 1859 by Huxley (**9**, pp. 30–66, pls. i.–v.). He restricted the family Diphyidæ to the genera *Diphyes* and *Abyla* in the sense of Eschscholtz, and separated them from *Praya*, as the type of another family, Prayidæ (Kölliker, **4**, p. 33). He gave, further, the first accurate description of numerous Diphyozooids (or Eudoxidæ), of seven different genera, and indicated probable ontogenetic connection with different forms of *Diphyes* and *Abyla*.

During my residence in the Canary Islands, from December 1866 to February 1867, I had the opportunity of examining typical representatives of all the eight genera of true polygastric Diphyidæ which are described in the sequel, and there I drew from nature the figures, which will be seen in Pls. XXXI. to XLII. of this Report. The greater number of the Diphyidæ, there observed by me, were afterwards found again in the collection of the Challenger, mainly in bottles containing surface animals, which were taken in the Tropical and Subtropical Atlantic (Stations 334 to 354; March 14 to May 7, 1876). In Lanzerote I observed directly the metagenesis of *Diphyes* (with *Cucullus*), *Diphyopsis* (with *Ersæa*), *Abyla* (with *Amphiroa*), *Bassia* (with *Sphenoides*), and *Calpe* (with *Aglaisma*).

Nectophores.—The two nectocalyces, which, in all Diphyidæ, are placed at the top of the stem, appear in three different stages of phylogenetic development, and these determine the division of the family into three divergent subfamilies. The first subfamily, Prayidæ, has two nectophores of nearly equal size and similar form, opposed to one another; sometimes the first is somewhat smaller than the second; their surface is rounded, the jelly-substance very soft. Their shape is either mitriform or reniform (*Praya*, Pl. XXXI.), or more hemispherical (*Lilyopsis*).

The two nectophores of the second subfamily, Diphyopsidæ (Pl. XXXIII.), are also of nearly equal size and similar form; but they are pyramidal, pentagonal, and placed one behind the other. Their junction is very loose in *Galeolaria*, whilst in *Diphyes* and *Diphyopsis* the apical part of the second is hidden in the hydrœcium of the first nectophore. The sharp edges are often elegantly denticulate, and the hyaline jelly-substance of the umbrella is rather hard and firm, cartilaginous, as also is that of Abylidæ (Pls. XXXV.–XL.).

The differentiation of the two nectophores attains the highest degree in the third subfamily, Abylidæ. The first (proximal or apical nectophore, often also called superior or anterior) is here always symmetrical and much smaller than the second (distal or basal nectophore, often called inferior or posterior); this is more or less asymmetrical. Both nectophores are here polyhedral, prismatic, or truncate-pyramidal, with numerous polygonal faces and sharp prominent edges. The form of the second nectophore and its basal ostium is especially characteristic; it offers three prominent wings in *Abyla* (*trigona*), four in *Bassia* (*tetragona*), and five in *Calpe* (*pentagona*).

Canals of the Nectophores.—Each of the two nectophores constantly possesses four radial canals in the subumbrella, which are united above the velum by a circular canal. The size, course, and form of the four vessels are very variable, according to the place of their apical junction, where the nectocalycine duct, coming from the top of the stem, enters into the subumbrella. This point of junction is usually placed not at the apex of the nectosac but in its ventral median line, more or less dislocated downwards, so that the ventral canal (*cv*) is shorter, and the dorsal (*cd*) longer than the two symmetrical lateral canals (*cx* right, *cl* left); the latter are often more or less curved or loop-shaped. The ventral canal is very short, rudimentary, or even lost, in the first nectocalyx of *Galeolaria*, because here the point of junction has quite descended, and the nectocalycine duct enters into the base of the subumbrella, instead of into the apex. The opposite dorsal canal is so much the longer.

Hydrœcium.—The differences which the hydrœcium offers in the Diphyidæ, have been already mentioned above. (p. 93). The Prayidæ are distinguished by a cylindrical hydrœcial canal open at both ends, composed of the ventral grooves of the two opposite nectophores, fitting one into another. *Galeolaria* has no true hydrœcium, since the apex of the second nectophore is simply attached to the base of the first, and the siphosome is suspended freely between them. All other Diphyidæ have a conical or campanulate hydrœcial cavity on the ventral side of the first nectophore, and as its continuation, a hydrœcial canal on that of the second; this is sometimes an open groove, protected by two overlapping wings, at other times a closed canal, produced by concrescence of the two wings.

Somatocyst (*cs*).—The acrocyst or somatocyst ("Saftbehälter") is wanting in the Prayidæ and in *Galeolaria*; it may be replaced in the former by the ascending pallial

canal. All other Diphyidæ possess a somatocyst in the first or apical nectophore; it must be regarded as the uppermost part of the original common stem, overgrown and enclosed by jelly-substance of the first nectophore. The somatocyst is usually rather large, spindle-shaped, or ovate, sometimes more cylindriaal, at other times more ovate. Usually it ascends from the apex of the hydrœcium; but in *Abyla* it descends along its ventral side. The structure is the same as in the other Calyconectæ (compare above, p. 93).

Siphosome.—The tubular trunk or common stem of the Diphyidæ is very contractile, and beset at regular intervals with the cormidia, the number of which is very variable. The stem is very long in the lower and older forms of the family, in the Prayidæ and *Galeolaria*, where it sometimes attains a length of more than one metre, and bears more than one hundred cormidia. Their size and number are much smaller in the specialised Abylidæ, intermediate in the Diphyidæ. The contracted stem may usually be retracted more or less completely into the hydrœcium. The structure of the stem is described above (p. 94).

Cormidia.—The cormidia of the Diphyidæ, or the Diphyozooids of Huxley (9, pp. 57–66), occur in two different principal forms, eudoxomes and ersæomes. The majority of the genera possess eudoxomes; each cormidium is composed of a sterile medusome (bract with siphon and tentacle) and a fertile medusome (gonophore). The two genera *Lilyopsis* and *Diphyopsis* possess ersæomes, a sterile special nectophore, as locomotive person, being added to the euxodome.

Bracts.—The bracts or hydrophyllia are of very different form and structure, characteristic of the single genera and even of the three subfamilies. The bracts are mitriform and rounded in the Prayidæ, spathiform or conical in the Diphyopsidæ, prismatic or polyhedral in the Abylidæ. Besides, the form and place of the phyllocyst, and the number, form, and course of the radial canals which arise from its base, exhibit characteristic differences in the various genera.

Siphon and Tentacle.—The form and structure of the polypites exhibit no important differences in the cormidia of the various Diphyidæ. The structure, too, of the tentacles is in general the same; but the special form of the tentillæ, and especially the composition of the cnidosacs and the arrangement of their different cnidocysts, are subject to many specific variations.

Eudoxiæ.—The minority of the Diphyidæ produce sessile eudoxomes, which maturate whilst attached to the stem. This is the case in some of the Prayidæ and in *Galeolaria*. In all the other Diphyidæ they become early detached from the stem, and maturate as free Eudoxiæ (compare above, p. 101).

Ontogeny.—On the development of the Diphyidæ, compare above, pp. 100–102.

Synopsis of the Genera of Diphyidæ.

I. Subfamily PRAYIDÆ. Two nectophores of nearly equal size and similar form, opposite to one another, edgeless, rounded.	Bracts of the cormidia hemispherical, cup-shaped or helmet-shaped, edgeless, rounded. Phyllocyst with four radial canals.	Cormidia (or Eudoxiæ) without special nectophores, . . .	24. *Praya.*
		Each cormidium (or Eudoxia) with a special nectophore, . . .	25. *Lilyopsis.*
II. Subfamily DIPHYOPSIDÆ. Two nectophores of nearly equal size and similar form, one placed behind the other, pyramidal, five-edged.	Bracts of the cormidia pyramidal, conical, or spathiform, with a pointed apex, and an obliquely bevelled basal face and a deep ventral fissure. Phyllocyst ovate, simple or rudimentary, without radial canals.	Cormidia without special nectophores, sessile. First nectophore without hydrœcium, . .	26. *Galeolaria.*
		Cormidia without special nectophores, free Eudoxiæ. First nectophore with a conical hydrœcium, . .	27. *Diphyes.*
		Each cormidium (or each Eudoxia) with a special nectophore, free. First nectophore with a conical hydrœcium, . .	28. *Diphyopsis.*
III. Subfamily ABYLIDÆ. Two nectophores of very different size and form, one placed behind the other; both prismatic, with polygonal faces and sharp edges.	Bracts of the cormidia six-sided prismatic. Phyllocyst descending, with two lateral canals at its apex.	Basal nectophore three-sided prismatic, with three wing-shaped edges. Mouth trigonal, . .	29. *Abyla.*
	Bracts of the cormidia four-sided prismatic, below wedge-shaped. Phyllocyst ascending, with an odd basal canal.	Basal nectophore four-sided, pyramidal, with four wing-shaped edges. Mouth tetragonal, .	30. *Bassia.*
	Bracts of the cormidia cuboidal, with a caudal apophysis. Phyllocyst with four radial canals.	Basal nectophore five-sided prismatic, with five wing-shaped edges. Mouth pentagonal, .	31. *Calpe.*

Subfamily PRAYIDÆ.

Genus 24. *Praya*,[1] Blainville, 1834.

Praya, Blainville, Manuel d'Actinologie, **24**, p. 137.

Definition.—Diphyidæ with two rounded, reniform or mitriform, edgeless nectophores of similar form and subequal size, opposed to one another. A hydrœcial canal is formed by the opposite hemicylindrical ventral grooves of the two nectophores. Bracts hemispherical, helmet-shaped or reniform. Phyllocyst with (four) radial canals. Cormidia without special nectophores.

[1] *Praya*=Porto Praya, the name of a place in the Cape Verde Islands, where this Siphonophore was first observed.

The genus *Praya*, and the following genus *Lilyopsis*, compose together the sub-family Prayidæ, differing from the other Diphyidæ (Diphyopsidæ and Abylidæ) mainly in the rounded, edgeless exumbrella of the nectophores, which consist of a particularly soft jelly-substance, much softer than in the latter. The two nectophores are of similar form and nearly equal size, one opposed to the other, and not the first before the second (as in the Diphyopsidæ and Abylidæ). The mitriform or reniform nectophores have a longitudinal furrow on their ventral side, and the two hemicylindrical furrows are so applied one to another as to form a hydrœcial tube, in which the upper part of the siphosome can be retracted. The bracts are navicular or reniform, provided with four irregular radial canals.

The best known type of the genus *Praya* is the large Mediterranean form described by Gegenbaur as *Praya maxima* (**7**, Taf. xvii. figs. 1–4). Perhaps different from this species is another Mediterranean form, which also inhabits the North Atlantic, *Praya cymbiformis*, delle Chiaje (**18**), very accurately described by Leuckart (**5** and **8**). A third species, differing from the two former in the form of the nectophores and bracts and their canals, is the tropical Atlantic *Praya galea*, which I observed living in the Canary Island Lanzerote, in February 1867. Scattered bracts of it are found in a bottle in the Challenger collection from Station 352.

Praya galea, n. sp. (Pls. XXXI., XXXII.).

Praya galea, Haeckel, System der Siphonophoren, 1888, p. 35.

Habitat.—Tropical and Subtropical Atlantic, Station 352; April 13, 1876; lat. 10° 55′ N., long. 17° 46′ W. Surface.

Canary Islands, Lanzerote, February 1867 (Haeckel).

Nectophores (Pl. XXXI. figs. 1–7, natural size; fig. 1, lateral view; fig. 2, dorsal view; fig. 3, apical view of the two united, fig. 4, of the two separated nectophores; fig. 5, first (smaller) nectophore from the left side; fig. 6, second (larger) nectophore from the right side; fig. 7, the same from the ventral side). The two large nectophores or nectocalyces, which are the powerful locomotive organs of the long chain-like body, are both of similar kidney-shaped form, but of different sizes. The first, apical or proximal nectophore is somewhat smaller than the second, basal or distal swimming bell; both possess a deep longitudinal groove on their ventral side, and are so opposite one to another at the top of the stem, that the larger distal bell is placed more below and embraces the smaller proximal bell by means of its two lateral ventral wings (figs. 3, 4). The smaller nectophore was in the largest specimen, which I examined living in the Canary Islands, 40 mm. long and 25 mm. broad; the larger (second) nectophore 50 mm. long and 35 mm. broad. Another specimen had only two-thirds of this size.

Each of the two nectophores has in general the form of a kidney or bean, with a deep longitudinal sulcus or groove at its ventral side, corresponding to the hilus of the kidney. This furrow is the hydrœcial sulcus (fig. 4, *ni*) included between the two lateral longitudinal wings of the bell (*nx* right wing, and *nl* left wing, in figs. 2–7). In the middle of this groove, in the ventral median line of the nectophore, arises its pedicle, a small triangular vertical plate (fig. 4, *np*). The proximal apex of the triangle (fig. 7, *np*) connects the bell with the top of the siphosome (fig. 4B, *a*). The dorsal or abaxial side of the nectophore, as well as its lateral sides, are equally rounded, without crests, and the two ventral nearly parallel longitudinal wings are its only edges. The jelly-substance of the umbrella is, as in the other species of the genus, extremely soft and nearly diffluent, so that the bell, taken out of the water, loses its natural form.

Nectosac.—The nectosac, or the subumbrellar cavity of the nectophores (figs. 5–7, *w*), is relatively larger than in the other species of the genus hitherto described. It occupies nearly the aboral half of the umbrella, whereas in the latter it takes up only one-third or one-fourth of it. The form of the nectosac is sometimes campanulate or ovate (figs. 1, 6), at other times hemispherical or subglobular (figs. 2, 5). Its axis is not identical with the longitudinal axis of the reniform bell, but inclined towards it at an acute angle. The basal opening of the nectosac is circular and surrounded by a broad velum (figs. 2, 6, *v*).

Canals of the Nectophores.—A short peduncular canal (figs. 5, 6, *cp*) passes from the top of the siphosome immediately to each nectophore, obliquely ascending in the apical bell, descending in the basal bell. The peduncular canal runs through the lamellar pedicle of the nectophore obliquely to the top of the nectosac, and gives off in this course two vertical blind pallial canals or "mantle-vessels," an ascending and a descending. The superior or ascending mantle-canal (figs. 2–7, *cs*) runs vertically upwards towards the top of the bell, near to the apical edge of its triangular peduncle, and may be regarded as the homologue of a somatocyst. The inferior or descending mantle-canal (figs. 2–7, *cs'*) runs in the opposite direction downwards, between the basal edge of the peduncle and the ventral canal of the nectosac, parallel to the latter. The four canals of the nectosac, which arise from the distal end of the peduncular canal, are arranged in two pairs of very different length and form. The ventral (*cv*) and the dorsal canal (*cd*) are nearly equal, and lie in the sagittal plane, following the simple curvature of the nectosac, whereas the two lateral canals (*cx* right, and *cl* left) are twice as long as the former, and form in their course a double sigmoidal loop; they descend from the top of the nectosac curved towards the dorsal face, then are bent twice downwards and twice upwards, and finally reach the circular canal near the ventral face (figs. 2–7).

Hydrœcium.—There is no true hydrœcium or funnel cavity in the genus *Praya*, but the two deep ventral grooves of the two opposite nectophores, or the funnel-furrows, (fig. 4A, 4B, *ni*), are so turned one to another, that there is formed a cylindrical hydrœcial canal, open at both ends. Its smaller apical half, with the upper aperture, is empty; its

larger basal half encloses the siphosome, which proceeds through its lower aperture; the two halves are separated by the apex of the trunk, from which arise also the pedicles of the two nectophores (fig. 4B, *a*; fig. 7, *np*). The two ventral wings of the larger basal nectophore (fig. 4B) embrace the two opposite ventral wings of the smaller apical nectophore (fig. 4A) so completely that the lateral sides of the hydrœcial canal are perfectly closed (fig. 3, apical view).

Siphosome (fig. 1).—The common trunk of the cormus is a cylindrical tube of the highest contractility, and in the contracted state is very short and partly hidden in the hydrœcial canal; in the fully expanded state it attains a length of more than two feet and offers a splendid aspect, the numerous cormidia (forty to fifty or more) being separated by equal intervals, each giving off a bright yellow contractile siphon, and a long tentacle with numerous tentilla, the latter armed with yellow cnidosacs.

Cormidia (Pl. XXXII.).—Each cormidium is a eudoxome, composed of two medusoid persons, a sterile medusome (siphon with bract and tentacle), and a fertile medusome (the gonophore). Sometimes two gonophores occur in the same group. The gonophores in the proximal part of the trunk are usually female, those in the distal part male; but sometimes both sexes alternate rather regularly. The cormus is therefore monœcious. The gonads are very small; often perhaps they do not become ripe until the Eudoxiæ have become detached from the stem, but usually they seem to ripen sessile on the trunk. Some free-swimming *Eudoxiæ*, belonging to the genus *Eudoxella* (Genus 11A) are so similar to the sessile Eudoxome of this species of *Praya*, that I suppose they have been detached from a species of this genus.

Bract (Pl. XXXII. fig. 8, *b*; fig. 9).—The bract or hydrophyllium (the umbrella of the sterile medusome) somewhat repeats the kidney-form of the nectophores. It attains a length of 10 to 12 mm., a height of 8 to 10 mm. Its jelly-wall is very thick and soft, mainly in the rounded apical half. The basal half is deeply excavated, and its thinner-walled cavity, corresponding to the subumbrella (*w*), encloses the siphon with its tentacle, and the gonophore. The convex exumbrella is rounded and smooth all round, and at its basal margin presents three deep sinuses or incisions, two paired lateral and one odd dorsal (fig. 9). The trunk of the siphosome (fig. 8, *a*) passes through the two lateral incisions, while the tentacle (fig. 8, *t*) steps out through the dorsal incision. Two lateral, nearly quadrangular lobes, comparable to the two buccal valves of a helmet, are separated by those sinuses.

Canals of the Bract (figs. 8, *c*, 9, *c*)—Each hydrophyllium must be regarded as the reduced umbrella of a Hydromedusa, and still possesses the four radial canals, characteristic of the latter. A short peduncular canal or apical vessel (figs. 8, 9 *ca*), goes from the trunk (*a*) to the apical part of the subumbrellar cavity, gives off a short spindle-shaped cæcum (phyllocyst), and four divergent, irregularly bent canals, two odd sagittal and two paired lateral. The odd ventral canals (*cv*) forms an S-shaped loop in the solid

jelly mass of the apical and ventral half of the nectophore. The odd dorsal canal (*cd*) runs along the convexity of its basal and dorsal half. The two paired lateral canals (*cx* right, *cl* left) pass into the two lateral lobes or buccal valves of the helmet-shaped bract. The blind ends of all four canals are somewhat swollen and club-shaped. Their course, as well as the mode of their apical junction, are very variable, and subject to many individual abnormalities. Usually the ventral canal is shorter than the dorsal, and the right shorter than the left.

Siphons (Pl. XXXI. fig. 1; Pl. XXXII. fig. 8, *s*; fig. 11).—The siphon or polypite, which is attached to the stem at the lateral incision of each bract by a very short pedicle, exhibits a hemispherical basigaster (*sb*), the thick wall of which is filled up by cnidoblasts. The stomach (*sh*) is ovate and exhibits eight broad yellow hepatic striæ (*sh*). The contractile proboscis (*sr*) is very muscular and opens through a mouth of very variable form (*so*). Sometimes the distal part of the siphon is so invaginated and retracted into the proximal part, that it assumes the peculiar form shown in fig. 11.

Tentacles (fig. 8, *t*; figs. 12–14).—The tentacle, which depends from the short pedicle of each siphon, is very long and mobile, cylindrical and distinctly articulated, beset with a series of very numerous tentilla or lateral branches. These arise from the constrictions between each two segments of the tentacle. Each tentillum (figs. 12–14) contains a canal, which is somewhat convoluted before entering into the dilated cnidosac (fig. 13). The latter is reniform or crescentic and contains a strong battery of cnidocysts, six to eight longitudinal rows of small medial paliform cnidoblasts (*km*), and on each side (right and left) a longitudinal series of large sabre-shaped lateral cnidoblasts (*kl*), eighteen to twenty-four in each series. Three groups of small pyriform thread-cells (an odd dorsal, kp_1, and two paired ventral, kp_{II}), are found on the base and on both sides of the distal end of the battery. The terminal filament of the tentillum (*tf*) forms in the contracted state three coiled spiral turnings.

Gonophores (fig. 8, *h*; fig. 10).—Each cormidium usually exhibits, half hidden under the bract, a single gonophore, either male or female. It is placed at the ventral side of the siphon, whilst the tentacle arises from its dorsal side. The umbrella of the gonophore (fig. 10) is laterally compressed, bilateral, and exhibits two very broad wings in the sagittal plane; the dorsal wing (*nd*) is triangular and nearly as large as the nectosac, whilst the ventral wing (*nv*) is much smaller. The nectosac (*w*) is hemispherical or campanulate, with a broad velum (*v*). The peduncular canal enters between the two wings into the jelly umbrella and gives off at the apex of the nectosac the four radial canals (*cd* dorsal, *cv* ventral, *cx* right, *cl* left). The spindle-shaped spermarium (fig. 8, *h*) and the ovate or subspherical ovarium (fig. 10, *f*) are rather small, and in the largest Eudoxiæ only fill the superior half of the subumbrellar cavity.

Genus 25. *Lilyopsis*,[1] Chun, 1885.

Lilyopsis, Chun, Sitzungsb. d. k. Akad. d. Wiss. Berlin, Feb. 5, 1885, p. 18.

Definition.—Diphyidæ with two rounded, hemispherical or mitriform, edgeless nectophores, of similar form and subequal size, opposed to one another. A hydrœcial canal is formed by the opposite hemicylindrical ventral grooves of the two nectophores. Bracts hemispherical, mitriform, or reniform. Phyllocyst with (four) radial canals. Each cormidium with a sterile special nectophore.

The genus *Lilyopsis* was founded by Chun in 1885 (**86**) for those Diphyidæ, formerly described as *Prayæ*, which differ from the true *Prayæ* in two important points. The Eudoxiæ of *Praya* are composed of two persons, a sterile medusome (bract with siphon and tentacle), and a fertile gonophore. The Eudoxiæ of *Lilyopsis* possess, besides, a third medusome, a sterile special nectophore, and usually they have a cluster of gonophores instead of a single fertile medusoid. *Lilyopsis*, therefore, bears the same relation to *Praya* that *Diphyopsis* has to *Diphyes*. The special nectophore is in some species of this genus more medusiform than in any other Siphonanthæ. It possesses a circle of numerous rudimentary tentacles at the margin of the umbrella, and, besides, often a number of red pigment spots, which may be regarded as ocelli. *Lilyopsis* agrees in this respect with the nearly allied *Desmophyes* (Pl. XXX.).

It is probable that in some species of *Lilyopsis* the cormidia are detached from the stem, and represent a self-subsistent free-swimming form of *Lilæa* (Genus 17B).

The first described species of *Lilyopsis* (1853) is the Mediterranean *Praya diphyes* of Vogt (**6**, Tab. xvi., xvii.) and of Kölliker (**4**, Taf. ix.). Another Mediterranean species was figured in 1870 by Metschnikoff under the name *Praya medusa*, and described in the Russian language, therefore inaccessible. It is probably the same as that of which Fewkes published a figure in 1880 (**42**). A third species, also Mediterranean, was announced by Chun in 1885 under the name *Lilyopsis rosea*.[2] A fourth species, *Lilyopsis catena*, similar to the latter, was observed by me in 1866 in the Canary Island Lanzerote, but not sufficiently examined.

Subfamily DIPHYOPSIDÆ.

Genus 26. *Galeolaria*,[3] Lesueur, 1807.

Galeolaria, Blainville, Manuel d'Actinologie, 1834, p. 139.

Definition.—Diphyidæ with two angular slenderly pyramidal nectophores of similar form and subequal size, one placed behind the other. First nectophore without hydrœcium. Cormidia without special nectophores. Bracts conical or spathiform, with a pointed apex. Phyllocyst small or rudimentary, without radial canals.

[1] *Lilyopsis* = Similar to a lily.

[2] **86**, p. 18, Taf. ii. figs. 12, 13.

[3] *Galeolaria* = Provided with small helmets, *galeola*.

The genus *Galeolaria* (confounded by later authors with *Epibulia*) was founded in 1807 by Lesueur, in a manuscript not published, for two Australian *Diphyes*, which were figured by Quoy and Gaimard under the names *Galeolaria australis* and *Galeolaria quadridentata* (2, pl. v. figs. 30–33). The same were afterwards regarded by Blainville as the types of this genus (24, p. 139). The first accurate description of two Atlantic species belonging to it was published in 1846 by Sars (under the names *Diphyes truncata* and *Diphyes biloba* (27, p. 41, Taf. vii.). A Mediterranean species was accurately described by Gegenbaur as *Diphyes turgida* (68), and another by Vogt as *Epibulia aurantiaca* (6). An Arctic *Galeolaria*, inhabiting the Greenland Sea, is *Diphyes sarsii* of Gegenbaur (10, Tab. xxx. figs. 30, 31). The Indian *Galeolaria filiformis* described by Huxley (9, pl. iii. fig. 5) is probably identical with the original *Galeolaria australis* of Lesueur. Different from all these species is the *Galeolaria stephanomia*, inhabiting the Tropical Pacific, described by Brandt as *Diphyes stephanomia* (25, p. 32). I was able to compare the excellent figure and description of it (unfortunately not published !) which Martens had taken from nature as early as 1827.

Galeolaria (synonymous with *Sulculeolaria* of Blainville) differs from *Diphyes* in the complete absence of a hydrœcium. The basal part of the truncate ventral side of the first nectophore is simply attached to the corresponding apical part of the second. Between them the siphosome depends freely. The nectocalycine ducts are therefore very different in the two nectophores, entering into the first at its base, into the second at its apex. The ventral radial canal is very short in the first, very long in the second nectophore. The ventral plate of the umbrella is prolonged in both nectophores over their basal ostium in the form of a bilobate lamellar apophysis (compare Leuckart, 8, p. 279, and Huxley, 9, p. 38). The gonophores ripen on the stem, and are not detached as free-swimming Eudoxiæ. The corms are dicecious (p. 99).

Genus 27. *Diphyes*,[1] Cuvier, 1817 (*sensu restricto*).

Diphyes, Cuvier, Le Règne animal, t. iv. p. 61.

Definition.—Diphyidæ with two angular, slenderly pyramidal nectophores, of similar form and subequal size, one placed behind the other. First nectophore with a conical or campanulate hydrœcium. Cormidia without special nectophores (free as *Cucullus*, Genus 12). Bracts pyramidal, conical, or spathiform, with a pointed apex. Phyllocyst simple, usually large and ovate, without radial canals.

The genus *Diphyes* was founded by Cuvier in 1817 upon the first figure published of any Calyconecta, the *Diphyes dispar* of Chamisso (16), which was figured first by Bory in 1804 under the name *Biphora bipartita* (13, p. 134). Eschscholtz gave in 1829 a more accurate description of *Diphyes*, and the following definition :—" Ductus nutritorius

[1] *Diphyes* = Double animal (διφυής); Calyconecta with a double nectophore.

tubulis pluribus obsitus. Tubuli squamis cartilagineis obtecti. Pars corporis nutritoria cavitate natatoria interna, extrorsum se aperiente instructa." He distinguished four different species, the fourth of which, *Diphyes appendiculata*, from the Pacific Ocean, is here retained as the representative type of the genus (**1**, p. 138, Taf. xii. fig. 7). Nearly allied to this are two Mediterranean species, *Diphyes acuminata* of Leuckart (**5**), and *Diphyes sieboldii* of Kölliker (**4**). A third Mediterranean species is *Diphyes subtilis* of Chun (**87**). Different from these is *Diphyes elongata*, Hyndman, from the northern Atlantic (**64**), and an Indian species, *Diphyes gracilis*. Huxley united all these species under the name *Diphyes appendiculata;* there seem to be, however, constant differences between these species, which may be considered as specific, the more so as they are inhabitants of widely distant seas. A more accurate distinction is required.

Gegenbaur, in 1859, distinguished not less than ten different species of the genus *Diphyes* (**10**, p. 50); the majority of these belong, however, to other genera of Diphyidæ, *Diphyopsis* (*Diphyes campanulifera*, &c.), and *Galeolaria* (*Epibulia quadrivalvis*, &c.).

The cormidia of *Diphyes* (in the sense here restricted) possess a spathiform or three-sided pyramidal bract, with a deep ventral fissure, and become mature as free Eudoxiæ belonging to the genus *Cucullus* (compare above, Genus 12).

Genus 28. *Diphyopsis*,[1] Haeckel, 1888.

Diphyopsis, Hkl., System der Siphonophoren, p. 35.

Definition.—Diphyidæ with two angular, slenderly pyramidal nectophores of similar form and subequal size, one placed behind the other. First nectophore with a conical or campanulate hydrœcium. Each cormidium with a special nectophore (free as *Ersæa*, Genus 17B). Bracts pyramidal, conical or spathiform, with a pointed apex. Phyllocyst simple, ovate, without radial canals.

The genus *Diphyopsis* comprises those Diphyidæ hitherto described as *Diphyes*, which differ from the true *Diphyes* in the possession of numerous special nectophores, each of which is the locomotive organ of a cormidium, swimming free as *Ersæa* (compare above, Genus 17). *Diphyopsis* bears the same relation to *Diphyes* that *Lilyopsis* has to *Praya*. The special nectophore of each cormidium (wanting in *Diphyes*) is the originally first gonophore, which has lost its sexual function, and produces no manubrium; it is subservient only to locomotion.

The first described species of *Diphyopsis* is *Diphyes dispar* of Chamisso and Eysenhardt, inhabiting the Tropical and Southern Pacific (**16**, p. 365, Tab. xxxiii. fig. 4). A very accurate description of it was given by Huxley (**9**, p. 30, pl. i. fig. 1). Probably identical with it is *Diphyes angustata* of Eschscholtz. The Challenger collection con-

[1] *Diphyopsis* = Similar to *Diphyes*.

tains specimens of this species, taken in different parts of the Pacific (*e.g.*, Stations 175, 222, 265 to 279, &c.).

A second species may be the Mediterranean *Diphyopsis campanulifera*, described as *Diphyes campanulifera* by Eschscholtz, first observed by Quoy and Gaimard in the Strait of Gibraltar.

A third species is described in the following lines as *Diphyopsis compressa*. It inhabits the Tropical and Subtropical Atlantic. The Challenger collection contains many specimens of it, taken between Stations 327 and 353.

Diphyopsis compressa, n. sp. (Pls. XXXIII., XXXIV.).

Diphyes compressa, Hkl., 1866, MS. Canar.

Habitat.—Tropical and Subtropical Atlantic, Stations 327, 334, 348, 352A.
Canary Islands, Lanzerote, December 1866 (Haeckel).

Nectophores (fig. 1, the two nectocalyces in their natural connection, seen from the left side; fig. 2, from the ventral side; fig. 3, from the dorsal side).—The two large swimming bells are of nearly equal size and similar form; their usual length is between 25 and 30 mm., the breadth between 10 and 15 mm., the thickness 5 to 7 mm.; the first or apical nectophore, however, is a little larger, longer as well as thicker, than the distal one. The former encloses on its ventral side a campanulate hydrœcium (and above its top a somatocyst); the latter an incomplete subcylindrical hydrœcial canal.

Apical Nectophore.—The first, superior, anterior or proximal nectocalyx, appears in the lateral view (fig. 1) as a broad triangle, the dorsal side of which (*nd*) is the longest and slightly convex; the opposite ventral side (*nv*) is more convex, one-fifth shorter, and twice as long as the obliquely bevelled basal side. The ratio of the three sides therefore is = 5 : 4 : 2. Seen from the ventral side (fig. 2), or from the dorsal side (fig. 3), the nectophore appears as a very long and narrow isosceles triangle, the two equal lateral sides of which are four times as long as the basal side. Seen from the basal face (fig. 8) it appears nearly rectangular, three times as long as broad, with a small triangle imposed on the dorsal side. The exumbrella therefore has the form of a bilateral pentagonal pyramid, which is very strongly compressed from both sides. Its surface exhibits five prominent ridges, one odd dorsal and two pairs of laterals, meeting in the slender pointed top of the nectophore. The odd dorsal ridge (figs. 1, 3, *nd*) runs in the median dorsal line of the exumbrella and ends below in the odd dorsal tooth of the mouth of the nectosac. The two dorso-lateral ridges run along the lateral faces of the nectosac and end below in the smaller dorso-lateral teeth of its mouth (n^1, n^2). The two ventro-lateral ridges run along the ventral face of the hydrœcium and end in two small ventral teeth (fig. 8, n^5 $n6^6$)

Between the former and the latter pair of ridges there arise in the basal third of the exumbrella two convergent incomplete medio-lateral ridges, which end in the two large ventro-lateral teeth of the nectosac mouth (n^3, n^4). The five teeth of the mouth and the basal parts of the ridges are elegantly denticulate.

Nectosac (figs. 1–3, *w*).—The umbrellar cavity of the first nectophore is nearly cylindrical, conical above, and in the contracted state four to six times as long as broad. It occupies two-thirds of the length of the umbrella, and is placed in its dorsal half, close to the ventral hydrœcium. From the top of the nectosac arises a long tubular cæcum, or a vertical apical canal (figs. 1, 2, *cp*); its blind end nearly reaches the outmost apex of the umbrella. The nectocalycine duct (or the peduncular canal of the first nectophore) descends from the top of the trunk obliquely towards the ventral side of the nectosac and enters into it at a point between the first and second third of its height. It divides here into the four radial canals of the nectosac. The shortest of these is the straight ventral, the longest is the loop-shaped dorsal canal. The two lateral canals are shorter than the latter, longer than the former, ascend like the dorsal, and then descend beyond the apex.

Mouth of the Nectosac (fig. 1, lateral view; figs. 3 and 7, dorsal view; figs. 6 and 8, basal view). The basal opening of the subumbrella is rather narrow, with a broad velum (*v*), and protected by five convergent teeth, the ends of the above-mentioned longitudinal ridges. The odd dorsal tooth (*nd*) and the two dorso-lateral teeth (n^1, n^2) are of nearly equal size, half as large as the two ventro-lateral teeth (n^3, n^4).

Hydrœcium (fig. 1, *ui*, lateral view; fig. 2, *ui*, ventral view).—The funnel-cavity of the first nectophore, or the hydrœcium, occupies the basal half of its ventral side. It is slenderly campanulate and two-thirds as long as the nectosac, which is placed closely at its dorsal side. The ventral half of the hydrœcium includes the peduncle or the apical apophysis of the second nectophore (*np*), the dorsal half the upper part of the siphosome. The basal mouth of the hydrœcium (fig. 8) is rectangular, three times as long as broad, and armed with four pointed teeth, two ventral (n^5, n^6), and two dorsal (n^3, n^4); the latter are the ventro-lateral teeth of the nectosac-mouth.

Somatocyst (figs. 1, 2, *cs*).—The acrocyst or the coryphal cavity of the first nectophore is a spindle-shaped or subcylindrical cæcal canal, half as long as the hydrœcium. It arises vertically from the top of the latter and extends over the top of the nectosac, about as far as the basal half of its apical cæcum.

Basal Nectophore (figs. 1 and 4 seen from its right side, figs. 3 and 5 from the ventral side).—The second, inferior, posterior or distal nectocalyx, is of the same length as the apical nectophore, but not so broad. The form of its dorsal half (with the nectosac and the quinque-dentate ostium) is very similar to that of the former; but it has no somatocyst, and the form of the ventral half and the apex are very different. The apical part, above the nectosac, is nearly as long as the latter, isosceles triangular, and elongated into a pointed apophysis, which is completely received within the hydrœcium

of the first nectophore. Along its dorsal side runs the nectocalycine duct or pedicular canal (*cp*), which opens at the apex into the top of the stem.

Hydrœcial Canal.—Whilst the dorsal half of the basal-nectophore is occupied by the slender, cylindrical, slightly curved nectosac, its ventral half is occupied by the hydrœcial canal (*nf*). This is an open groove in the greater part of its length, limited by two ventro-lateral wings of the umbrella; but in the middle part (opposite to the superior third of the nectosac) the two wings have grown together and form a complete canal (figs. 4, 5 *ub*,), and in the inferior third the broader left wing (*nl*) overlaps the smaller right wing (*nx*). The five denticulate edges of the second nectophore and the five basal teeth around the mouth correspond to those of the first.

Siphosome (fig. 1, *a*).—The common stem of the body is a very long and slender tubule in the expanded state, four to six times as long as the nectophores. It is enclosed in the hydrœcial canal of the basal nectophore, is attached at the apex to the top of the hydrœcium of the apical nectophore, and is here directly prolonged into the somatocyst of the latter (*cs*). Whilst a great part of the siphosome can be retracted into the hydrœcial canal when contracted perfectly, it can be widely prominent by its lower aperture when expanded.

Cormidia.—The eudoxomes, which beset the whole stem at regular intervals (about equal to their lengths) are very numerous, in large specimens sixty to ninety, or more (fig. 1). They have a spathiform bract, which is prolonged above its insertion upwards into a cowl (Pl. XXXIV. figs. 9, 11). This cowl is open at the ventral side, and contains a spindle-shaped phyllocyst (*cs*), which encloses in its apex an oleocyst (*co*). The ventral side of the bract is opened by a deep fissure, and its base obliquely bevelled, and armed with four short triangular teeth; the two dorsal teeth are larger than the two ventral.

The cavity of the bract encloses a cylindrical siphon with a long tentacle, and besides a large special nectophore, and one or two, rarely three, gonophores. These are brought to maturity after the eudoxome has been detached from the stem. It then swims freely about as *Ersæa compressa* (compare the description of this genus, pp. 122–124, and Pl. XXXIV.).

Subfamily Abylidæ.

Genus 29. *Abyla*,[1] Quoy et Gaimard, 1827.

Abyla, Quoy et Gaimard, Ann. d. Sci. Nat. (Zool.), t. x.

Definition.—Diphyidæ with two angular, pyramidal or prismatic nectophores of different size and form. The basal nectophore is three-sided-pyramidal, asymmetrical, and much larger than the symmetrical apical nectophore. Bracts six-sided-prismatic, with

[1] *Abyla* = Ἀβύλη, the southern column of Hercules, opposite to Calpe, Strait of Gibraltar.

a vertically descending phyllocyst, and two lateral, horizontally diverging canals, arising from its apex (*Amphiroa*, Genus 14).

The genus *Abyla* was founded by Quoy and Gaimard (1827, **20**) for the Mediterranean *Abyla trigona*, observed by them in the Strait of Gibraltar. I retain this species as the characteristic type of the genus, *sensu strictiori*. The majority of later authors have united with this typical species the very different Diphyidæ which belong to the two following genera, *Bassia* and *Calpe*. But the characteristic form of the nectophores, as well as of the bracts, justifies the separation of these three genera of Abylidæ. The large distal or inferior nectophore is trigonal in *Abyla*, tetragonal in *Bassia*, and pentagonal in *Calpe*. The polyhedral form of the hydrophyllia or bracts, too, exhibits characteristic differences in the three genera, and their phyllocysts give off two horizontal lateral canals in *Abyla*, one odd descending canal in *Bassia*, and four canals (one ascending, one descending, and two lateral) in *Calpe*. The free Eudoxia of the first genus is *Amphiroa*, of the second *Sphenoides*, and of the third *Aglaisma*.

The new species of *Abyla*, here described as *Abyla carina*, differs as well from the well-known Mediterranean *Abyla trigona*, very accurately described by Gegenbaur (**10**, Taf. i., ii.), as from the species inhabiting the Tropical Pacific which Huxley has described under the same name (**9**, pl. iii., fig. 1); I call this latter *Abyla alata*. Different from these is *Abyla leuckarti* of Huxley (**9**, pl. iii fig. 2), inhabiting the Southern Pacific. I observed myself *Abyla carina* in 1867 in the Canary Island Lanzerote, and made there the drawings reproduced on Pls. XXXV. and XXXVI. from the living specimen. The same species occurred in a bottle in the Challenger collection, taken at Station 348.

Abyla carina, n. sp. (Pls. XXXV., XXXVI.).

Habitat.—Tropical and Subtropical Atlantic; Station 348; April 9, 1876.
Coast of Sierra Leone, lat. 3° 10′ N., long. 14° 51′ W. Surface.
Canary Islands, Lanzerote, February 1867 (Haeckel).

Nectophores.—The two nectocalyces united are 35 to 40 mm. long; they are very different in form and size. The distal or posterior nectophore is 25 to 30 mm. long and 12 to 14 mm. broad, about twice as large as the proximal or anterior, the length of which is 10 to 12 mm., the breadth 7 to 8 mm. The ground-form of the smaller is symmetrical, of the larger asymmetrical.

Apical Nectophore (fig. 3, apical view, from above; fig. 4, basal view, from below; fig. 1 and fig. 5, lateral view, from the left side; fig. 6, ventral view; fig. 7, dorsal view).—The first nectophore (the proximal, anterior, superior or apical nectocalyx) is a hexagonal prism of a completely symmetrical bilateral ground-form. When the axis of the nectosac stands vertically (as in figs. 5–7), then the six lateral faces of the prism

are also nearly vertical; whilst the two terminal faces (superior and inferior) bear a pyramidal apophysis.

The six lateral faces are two odd and four paired. The dorsal odd face (fig. 7) covers the nectosac, and is nearly rectangular, twice as long as broad, its superior edge a little longer than the inferior. The opposite ventral odd face, covering the somatocyst (fig. 6, *uv*) is smaller, isosceles triangular, three times as long as broad; the apex of the triangle is directed downwards, the two lateral edges are convex. The two paired ventro-lateral faces (fig. 5, *cs*) are quadrangular, their dorsal edge longer than the parallel ventral, and the straight superior edge smaller than the concave inferior. The two paired dorso-lateral faces cover the lateral sides of the nectosac (fig. 5, *w*), and are hexagonal; their two parallel, nearly vertical, lateral edges are two to three times as long as each of the two superior or the two inferior edges.

The apical or superior face (fig. 3) of the hexagonal prism is not a simple face, but divided by a prominent transverse frontal crest (fig. 3, *ut*) into two unequal apical facets, a dorsal and a ventral. The dorsal apical facet is far larger, and covers the apex of the nectosac (fig. 3, w^1); it is hexagonal, with two odd and four paired edges; the odd dorsal and ventral edges (*ut*) are parallel and of equal length; they are longer than the two ventro-lateral, and smaller than the two dorso-lateral, deeply emarginated edges.

The ventral apical facet is quadrangular, much smaller, and covers the top of the somatocyst (fig. 3, *cs*). Its two lateral edges are twice as long as the inferior and superior edge (fig. 3, *ut*), and are so deeply emarginated that the facet appears to be nearly bisected by a frontal constriction.

The basal face of the hexagonal prism (fig. 4) is also divided by a prominent transverse frontal crest into two unequal basal facets, a dorsal and a ventral. The dorsal basal facet is square, and contains the opening of the nectosac (fig. 4, w^1). The ventral basal facet contains the opening of the hydrœcium (fig. 4, *ui*), and is isosceles triangular; the apex of the triangle is directed ventrally, and meets with the apex of the triangular ventral face (fig. 6, *cs*).

The interior of the first nectophore contains the nectosac (*w*) in its dorsal third, the somatocyst (*cs*) in its ventral third, and between both the hydrœcium (*ui*) in the middle third. The longitudinal axes of these three organs are nearly parallel, a little convergent towards the apex (fig. 5).

Nectosac (figs. 1 and 5, *w*, from the right side; fig. 7, *w*, from the dorsal; fig. 3, from the apical; fig. 4, from the basal side).—The subumbrella is subcylindrical, four times as long as broad; it occupies the dorsal third of the first nectophore, and is separated by a very thin frontal septum from the adjacent hydrœcium. The nectocalycine duct is very short, and enters into the bent apex of the nectosac, so that the four radial canals of the latter are very regular, and of nearly equal length. The basal opening of the nectosac is very small, and surrounded by a small velum (fig. 4, *v*).

Hydrœcium (figs. 1, 5, *ui*, from the right side; fig. 4, from below). The infundibulum of the first nectophore, or the hydrœcium, occupies its middle third, and is larger than both the nectosac (*w*) at its dorsal, and the somatocyst (*cs*) at its ventral side. It is slenderly campanulate or conical, in the superior half rather cylindrical, in the inferior much dilated. Its blind apex reaches nearly the frontal crest of the apical face. Its basal opening is isosceles triangular (fig. 4, *ui*); the base of the triangle is formed by the prominent frontal septum, whilst the apex meets with the inferior apex of the triangular ventral face of the nectophore.

Somatocyst (figs. 1, 5, *cs*, lateral view; fig. 6, *cs*, ventral view).—The somatocyst is a very large cylindrical sac, and occupies the ventral third of the first nectophore. Its cavity is nearly filled with large vacuolated polyhedral entoderm-cells. It is separated by a thin septum from the ventral wall of the hydrœcium. A short bent canal connects its apex with the top of the common stem.

Basal Nectophore (figs. 1, 9, lateral view from the left side; fig. 10, distal part from the right side; fig. 8, ventral view; fig. 11, basal view).—The second nectophore (the distal, inferior, or basal nectocalyx) is about twice as long and broad as the first, and has in general the form of an asymmetrical pentagonal pyramid; but three of its five edges are far more developed than the other two, so that the general appearance of the irregular pyramid is more trigonal. Its apex is a curved conical condyle, its base rounded.

The five edges of the basal nectophore, one odd dorsal and four paired, corresponding to those of *Diphyes* and *Calpe*, are developed in a different manner; the largest and most prominent wing is the right ventro-lateral edge (*nx*), and next to it the obliquely opposed left dorso-lateral edge (n^1). The odd dorsal edge (*nd*) is of intermediate size. The left ventro-lateral edge (*nl*) is short and broad in the middle part; the right dorso-lateral edge is the smallest, and more rudimentary.

The hydrœcial canal of the second nectophore is an open groove on its ventral side, protected by the two broad ventro-lateral wings, the right of which (*nx*) is much larger and overlaps the left (*nl*). The shorter left wing is prominent as a vertical triangular plate, the inferior part of which is broad and its margin strongly dentate (figs. 8, 9, *nl*). The larger overlapping right wing (*nx*) is more crescentic, and has a convex dentate margin, which is much thickened in the inferior third; the free basal edge of this thickened margin bears two parallel rows of teeth; the right row (*nx''*) is somewhat larger than the left (*nx'*, figs. 8 11).

The apical condyle of the triangular pyramid (figs. 8, 9, *nq*) on the articular apophysis of the second nectophore, which fits into the hydrœcium of the first and connects them, is curved and beak-shaped; it contains on its concave ventral side a deep hydrœcial groove, in its convex dorsal part the nectocalycine duct (*cn*).

The base of the second nectophore, seen from below (fig. 11), offers a very peculiar

aspect, distinguishing the genus *Abyla* at once from the other Abylidæ. Its outline is irregularly triangular, and its sagittal axis (vertical in fig. 11) one and a half times as long as the frontal (horizontal) axis. The three more prominent wings are so turned in the inferior part that the basal edge of the right ventro-lateral wing (*nx*) occupies the ventral half of the sagittal axis, and is just opposed to the dorsal wing (*nd*). The left dorso-lateral wing (n^1), on the other side, occupies the left half of the frontal axis. The five strong denticulate teeth, which form the basal ends of the five lateral wings, are so turned that the basal mouth of the second nectophore, beyond the ostium of the nectosac, forms a broad transverse or frontal fissure (like the mouth of a Plagiostome), and perpendicular to this is a larger ovate longitudinal fissure (in the dorsal half of the sagittal axis).

Nectosac (figs. 8–10, w^2).—The subumbrella of the second nectophore is very long, subcylindrical, about six times as long as broad. Its apex touches the base of the apical condyle (*nq*) and receives the nectocalycine duct (*cn*), which passes through the latter. The four radial canals of the subumbrella are regularly disposed, and united by a small velum at its basal opening (fig. 11, *uo*). This opening is strongly protected and partly hidden by the five basal teeth proceeding from the five wings of the exumbrella, and described above (fig. 11).

Siphosome.—The common stem, when contracted, is completely hidden in the hydrœcial canal described above. When the animal floats quietly on the surface of the tranquil sea it offers the peculiar aspect figured in figs. 1 and 2, Pl. XXXV., which I drew from a living, intact specimen, 11th February 1867, in the Canary Island Lanzerote. The longitudinal axis of the body (marked by the straight line of the expanded stem, on the dorsal median line of the hydrœcial canal) is so inclined that it *cuts* the horizontal level of the sea at an angle of 20°. The level is touched by the most prominent dorsal parts of the body, the frontal crest of the first nectophore, and the uppermost part of the dorsal edge of the second. A bunch of fishing tentacles issues through the basal opening of the hydrœcial canal.

Cormidia.—The Eudoxiæ attached to the siphosome, forty to sixty or more, are regularly arranged in the usual ordinate manner, and do not reach sexual maturity before being detached from the common stem. After being detached, they swim freely about as Eudoxiæ, which assume the characteristic form of *Amphiroa carina* described above (Genus 16). They are distinguished from other Eudoxidæ by the six-sided prismatic bract, with its large vertically descending dorsal phyllocyst, and the two horizontal lateral canals arising perpendicularly from its uppermost apex (compare p. 114 and Pl. XXXVI.).

Genus 30. *Bassia*,[1] Quoy et Gaimard, 1827.

Bassia, Quoy et Gaimard, MS. (compare Lesson, Acalèphes, p. 451).

Definition.—Diphyidæ with two angular, pyramidal or prismatic nectophores of different size and form. The basal nectophore is four-sided pyramidal, asymmetrical, and much larger than the symmetrical apical nectophore. Bracts, four-sided prismatic and wedge-shaped below, with an ovate, ascending phyllocyst, and an odd descending canal arising from its base (*Sphenoides*, Genus 15).

The genus *Bassia* was founded by Quoy and Gaimard in 1827 for a Diphyid which they found in Bass Strait, and called, from its four-sided nectophore, *Bassia quadrilatera*. The majority of later authors have called it *Abyla quadrilatera* (following Blainville, **24**), or *Abyla bassensis*, following Huxley, who gave an excellent description of it in 1859 (**9**, p. 45). Another species, from the Tropical Atlantic, taken off the coast of Guinea, was described at the same time very accurately by Gegenbaur under the name *Abyla perforata* (**10**, p. 26, figs. 20, 21). I myself have observed a third species in the Indian Ocean (*Bassia tetragona*), and a fourth species, different from the three others, in the Canary Islands, *Bassia obeliscus*. Since the latter also occurs in a bottle in the Challenger collection, taken in the Northern Atlantic, near the Azores (Station 354, May 6, 1876), I give its special description here, and the figures which I drew in 1867 from living specimens in Lanzerote. *Bassia* differs from *Abyla* (with trigonal nectophore) and *Calpe* (with pentagonal nectophore) in the tetragonal shape of its distal nectophore, which retains better the original form of a quadrilateral Medusa-umbrella. It differs further in the peculiar form of its wedge-shaped hydrophyllia and Eudoxiæ, which are free *Sphenoides* (p. 116) with an odd basal canal descending from the phyllocyst.

Bassia obeliscus, n. sp. (Pls. XXXVII., XXXVIII.).

Abyla obeliscus, Hkl., 1867, MS. Canar.

Habitat.—Northern Atlantic; Station 354, south of the Azores, west of the Canary Islands, May 6, 1876; lat. 32° 41′ N., long. 36° 6′ W. Surface.

Canary Islands, Lanzerote, February 1867 (Haeckel).

Nectophores.—The two nectophores united are 12 to 16 mm. long, 5 to 7 mm. broad; they are very different in form and size. The distal or posterior nectophore is 10 to 12 mm. long, 5 to 7 mm. broad; twice as long and broad as the proximal or anterior. The ground-form of the latter is symmetrical, that of the former asymmetrical.

Apical Nectophore (fig. 5 seen from the ventral face, fig. 6 from the dorsal face, fig. 7 from the coryphal edge or the original top, fig. 8 from the basal face).—The apical

[1] *Bassia* = Inhabitant of Bass Strait.

nectophore (first, superior or proximal nectocalyx) has the form of a pentagonal prism. Its main axis is 5 mm. long, lies in the natural position of the vertical cormus (figs. 1–4) nearly horizontally, and is therefore perpendicular to the vertical main axis of the large basal nectophore. The latter is three times as long as the former. The length of the main axis of the apical nectophore equals the sagittal diameter of the basal nectophore.

The dorsal face of the apical nectophore (fig. 6) is pentagonal, and in the natural position of the vertically standing cormus directed upwards (fig. 1–3, *ud*). Seen from above (fig. 6) the somatocyst (*cs*) and the nectosac (*w*) are visible through the transparent dorsal face. The ventral face (fig. 5) is heptagonal, in the natural position (figs. 1–4) directed downwards, and bisected by a horizontal transverse crest. The apical half of the bisected face is pentagonal, slightly concave, and through it appears the somatocyst (fig. 5, *cs*), whereas the basal half is excavated, and contains the campanulate hydrœcium (fig. 5, *ui*), in the fundus of which the siphosome arises. The basal face of the apical nectophore (fig. 8) is square with four equal concave edges, and in its centre is placed the aperture of the nectosac (*uo*). The remaining four faces are two basi-laterals and two apici-laterals; the former are pentagonal, the latter tetragonal; and these two are separated by the coryphal crest or sagittal edge (*nk*).

The Nectosac of the Apical Nectophore (fig. 6, *w*; fig. 8, *w*) is ovate and occupies its basal half. Its circular basal aperture (fig. 8, *uo*) is small and surrounded by a broad velum (*v*), and a circular canal (*cc*). The four radial canals of the subumbrella, which discharge into the latter, are of unequal length; the ventral canal (*cv*), near the hydrœcium, being shorter, the dorsal canal (fig. 6, *cd*) longer than the two curved lateral canals (*cx* right, *cl* left). The four radial canals unite in the apex of the nectosac, which is united by a very short peduncular canal with the apex of the siphosome.

Somatocyst (figs. 1, 2, 5, 6, 7, *cs*).—The somatocyst is subglobular, or spheroidal, with slightly shortened main axis. It occupies the apical half of the proximal nectophore and is nearly filled with large polyhedral entoderm cells, so that its central cavity is very small. It is everywhere surrounded by the thick jelly-mass of the umbrella, and only at its base in contact with the apex of the nectosae (fig. 6, *w*) and with the meeting apex of the hydrœcium (fig. 5, *ui*) and the siphosome.

Hydrœcium (fig. 1, *ui*; fig. 5, *ui*).—The hydrœcium or the funnel-cavity is campanulate or obliquely conical, and its wide quadrangular mouth occupies the basal half of the ventral face of the apical nectophore. The main axis of the hydrœcium is obliquely inclined, and in the normal position (figs. 1, 2) directed from above and behind downwards and forwards. The apex of the hydrœcium is the common central point, in which the somatocyst meets with the peduncular canal of the apical nectophore and the apex of the siphosome.

The Basal Nectophore (figs. 1–4), or the distal nectocalyx, has in general the form of an obelisk, or of a truncated four-sided pyramid. Its main axis is vertical in the normal

position, and therefore perpendicular to the horizonal main axis of the smaller apical pneumatophore. The truncated apical or upper face, where it unites with the latter (fig. 10), exhibits a short condyle or apical apophysis, is deeply notched, and presents a sort of articular face, into which the solid angle of the apical nectophore, formed by the junction of its two ventral faces, is received. The siphosome (fig. 10, *a*) enters through the apical apophysis into the hydrœcial canal (*ui*).

The opposite basal face of the basal nectophore (fig. 9), or the base of the obelisk, is nearly rectangular; its sagittal diameter is twice as great as its frontal axis. The centre of the dorsal half of the basal face is occupied by the small aperture of the nectosac, which is surrounded by a broad velum (*v*) and the circular canal, whereas the ventral half of the basal face contains the wide opening of the funnel canal (*ui*) through which the trunk (*a*) proceeds. The four corners of the basal face are somewhat asymmetrical and project downward as irregular three-sided pyramids; the two dorsal corners are smaller than the two ventral; the right dorsal corner (u^3) is the smallest, and the right ventral corner (u^1) the largest.

The four lateral faces of the basal nectophore (standing vertically in figs. 1–4) are nearly rectangular, slightly concave, and separated by four prominent, finely serrated edges. The nectosac is seen through the dorsal face (fig. 4, *w*), the hydrœcial canal with the included siphosome through the ventral face (fig. 3, *a*). This latter is bisected in the basal half by the hydrœcial fissure; a broad dentate plate stretching from the right ventral ridge (u^1) over the smaller opposite plate, which arises from the left ventral ridge (u^2). These two ventro-lateral crests are stronger and project more downwards over the basal face than the two dorso-lateral crests; the right of these (u^3) is somewhat larger than the left (u^4). The four interradial crests are not rectilinear, but slightly curved, S-shaped, and turned a little spirally around the vertical main axis.

The Nectosac of the Basal Nectophore (figs. 1–4, *w*) is slenderly ovate and occupies its dorsal half. It is twice as broad and three times as long as the nectosac of the apical nectophore. The dorsal face is more strongly vaulted than the ventral. The circular basal aperture is small and surrounded by a broad velum (*v*). The four radial canals of the subumbrella, which discharge into the circular canal, are of unequal length; the ventral (*cv*) is shorter, the dorsal (*cd*) longer than the two curved lateral canals (*cx* right, *cl* left). The four canals do not meet in the apex of the nectosac, but a little beyond it on the ventral face; and from their meeting point arises a rather long peduncular canal, which ascends nearly vertically, pierces the articular apophysis of the upper face of the nectosac, and unites at its apex with the top of the siphosome (figs. 1, 10).

The Hydrœcial Canal occupies the half of the basal nectophore; it is rather narrow, subcylindrical, and is separated by a thin jelly-plate from the ventral side of the neighbouring nectosac. Its apical opening (fig. 10) is obliquely truncate, ovate, and opens into the apical dorsal part of the apical nectophore (fig. 1). Its basal opening (fig. 9, *ui*)

is far larger and subcircular. The ventral margin of the latter is cleft in its middle; the large dentate plate arising from the right ventral crest of the basal nectophore here covers, like a valve, the free margin of the smaller plate which arises from the opposite left crest (figs. 3, 9, *uk*).

The Siphosome, which arises in the apex of the hydrœcium of the apical nectosac, enters into the hydrœcial canal of the basal nectosac by its apical aperture, runs through it along the ventral face of the nectosac, and proceeds freely through its basal aperture (fig. 1). In its contracted state, however, the retracted siphosome is completely hidden in the hydrœcial canal (fig. 2).

Cormidia.—The numerous cormidia, which are attached to the stem of the siphosome, are separated by regular free internodes, and become mature in the form of free Eudoxiæ, which belong to the monogastric genus *Sphenoides* (compare Genus 15 and Pl. XXXVIII.). These are characterised by the peculiar wedge-form of their bracts, and mainly by the odd spur-shaped dorsal canal, which descends from the base of the large ovate phyllocyst downwards.

Genus 31. *Calpe*,[1] Quoy et Gaimard, 1827.

Calpe, Quoy et Gaimard, Ann. d. Sci. Nat., 1827, t. x. p. 11.

Definition.—Diphyidæ with two angular, pyramidal or prismatic nectophores of different size and unequal form. The basal nectophore is five-sided pyramidal, asymmetrical, and much larger than the symmetrical apical nectophore. Bracts cuboidal, with a five-sided pyramidal apophysis, and a vesicular phyllocyst, from the base of which four canals arise, two slender odd sagittal and two broader paired lateral canals (*Aglaisma*, Genus 16).

The genus *Calpe* was founded by Quoy and Gaimard in 1827 for the well-known Mediterranean species *Calpe pentagona*. Eschscholtz (**1**, p. 132), and the majority of later authors, have described this striking form under the name *Abyla pentagona* (Kölliker **4**, Leuckart **5**, Huxley **9**, Gegenbaur **10**, &c.). But, besides the other characters, the pentagonal form of the distal nectophore distinguishes the true *Calpe* at once from the trigonal *Abyla* and the tetragonal *Bassia*, and still more the different form of the bracts in these three genera of Abylidæ. The phyllocyst of the true *Calpe* gives off four radial canals, two of which are odd and slender (an ascending and a descending), and two others paired and lateral. The free Eudoxia belongs to the monogastric genus *Aglaisma* (Genus 16). It was in this genus that Leuckart (**5**) and Gegenbaur (**7**), both independently, at the same time, observed the detachment of free Eudoxiæ from the Diphyid corm (compare above, p. 90).

The new species of *Calpe*, described in the following as *Calpe gegenbauri*, inhabits

[1] *Calpe* = Urn, Κάλπη; also the northern column of Hercules, opposite to *Abyla*, Strait of Gibraltar.

the Tropical and Subtropical Atlantic, and was collected by the Challenger at Stations 338 and 346. In 1867 I had observed the same species living, during my stay in the Canary Island, Lanzerote. A comparison of its form (Pl. XXXIX.) with the figures of the Mediterranean *Calpe pentagona* exhibits, at first sight, the important differences between the two species. A third species, different from both, is the inhabitant of the Tropical Pacific and Indian Ocean, figured by Huxley in his excellent work also as *Abyla pentagona* (9, pl. ii. fig. 2). I name it in honour of this naturalist, so highly respected for his additions to our knowledge of the Acalephs, *Calpe huxleyi*.

Calpe gegenbauri, n. sp. (Pls. XXXIX., XL.).

Habitat.—Tropical and Southern Atlantic; Station 338, March 21, 1876; lat. 21° 15′ S., long. 14° 2′ W.

Station 346, April 6, 1876; lat. 2° 42′ S., long. 14° 41′ W. Surface.

Canary Islands, Lanzerote, February 1867 (Haeckel).

Nectophores.—The two nectocalyces united are 24 to 28 mm. long; they are very different in form and size. The posterior or distal nectophore is 20 to 22 mm. long and 9 to 10 mm. broad; it is twice as broad and four times as long as the anterior or proximal, whose length is 5 to 6 mm., and the breadth 4 to 5 mm. The ground-form of the larger is very asymmetrical, that of the smaller quite symmetrical.

Apical Nectophore (figs. 1–4, *cs*; fig. 5, apical view; fig. 6, dorsal view; fig. 7, ventral view; fig. 8, lateral view from the left side).—The first nectophore (also called the proximal, anterior, superior or apical nectocalyx) is a pentagonal prism of a completely bilaterally symmetrical ground-form. When the axis of its nectosac stands vertically, then the two pentagonal and parallel terminal faces of the prism are also vertical, and one of their five angles (opposed to the basal side) is directed upwards; the two odd apical angles being connected by the horizontal coryphal crest (figs. 5–8, *nk*).

The pentagonal dorsal face of the first nectophore (fig. 6, *ud*) covers the nectosac (*w*), and is much smaller than the similar ventral face (fig. 7, *uv*), through which the somatocyst (*cs*) appears, and beyond it the hydrœcium (*ui*). The two superior lateral angles of each pentagonal terminal face are much more distant than the two inferior; and the lines connecting the two angles at each side (the inferior lateral edges of each pentagon) are turned inwards, and form an obtuse angle.

The five lateral faces of the pentagonal prism, which separate its two parallel terminal faces (dorsal and ventral) are two pairs of lateral faces (superior and inferior), and an odd inferior or basal face (with the openings of the dorsal nectosac and the ventral hydrœcium).

The two paired supero-lateral faces of the first nectophore are quadrangular, nearly rectangular, and connected in the sagittal axis of the body by the coryphal crest (*nk*);

the latter separating them like the ridge of a house-roof. The middle of the coryphal edge is nearly in contact with the oleocyst (*co*).

The two infero-lateral faces of the first nectophore are much larger, and of a more complicated form, sexangular; the ventral half of their larger quadrangular upper part being prolonged into an obliquely quadrangular descending plate of half its size (fig. 8); this plate forms the lateral wall of the hydrœcium (*ui*). The inferior dorsal angle of this plate (between the openings of the hydrœcium and the nectosac) is the lowermost point of the first nectophore; it marks the basal pole of its principal axis, whilst the apical pole of the latter is formed by the opposite oleocyst (*co*), and the centre of the coryphal edge (*nk*).

The inferior or the proper basal face of the first nectophore (opposed to the coryphal crest, *nk*, fig. 8) is divided by a prominent frontal septum (*nt*) into two divergent obliquely ascending secondary faces; the dorsal or posterior of these is quadrangular and contains the opening of the nectosac (fig. 6, *uo*); the ventral or anterior is pentagonal and contains the mouth of the hydrœcium (fig. 7, inferior third). The basal edge of the frontal septum is emarginate.

First Nectosac (figs. 5–8, *w*).—The subumbrella of the apical or proximal nectocalyx occupies its dorsal half, and is separated by the frontal septum from the ventral parts, the somatocyst (*cs*) in the upper, and the hydrœcium (*ui*) in the lower half. The nectosac is subcylindrical, four times as long as broad; its closed upper end is near the dorsal end of the coryphal crest (*nk*); the ostium of its lower end (*uo*) is surrounded by a small velum, and opens in the dorsal half of the basal face.

Canals of the Nectosac (figs. 5–8).—A nectocalycine duct (*cn*) arises from the apex trunci or the top of the hydrœcium, and ascends obliquely to the dorsal face of the nectosac (fig. 8, *w*). It divides here into four radial canals; the shortest is the descending ventral canal of the nectosac, the longest the opposite dorsal canal (fig. 6, *cd*), both placed in the median place of the nectophore; intermediate in size are the two paired lateral canals (right *cx*, and left *cl*); these form a small arch in their upper part. A far larger arch is formed by the dorsal canal, which ascends to the top of the nectosac and descends along its whole dorsal median line.

Hydrœcium (fig. 7, *ui*, ventral view; fig. 8, *ui*, lateral view from the left side).—The hydrœcial or funnel cavity is campanulate and occupies the basal half of the ventral part of the first nectophore. Its rounded apex is closed and from it arise the two small canals running to the nectophore and the somatocyst. The larger dorsal wall of the hydrœcium is formed by the frontal septum (*nt*), which separates it from the neighbouring nectosac. The smaller ventral wall is deeply emarginate (fig. 7). The inferior opening of the hydrœcium is quadrangular, obliquely truncated, with four prominent points or teeth. The two dorsal teeth are the inferior corners of the frontal septum, and much stronger than the two ventral teeth.

Somatocyst (figs. 5–8, *cs*).—The somatocyst is spherical, very large, and occupies the apical half of the ventral part of the first nectophore. It is filled with large vacuolate entoderm cells and therefore appears reticulate. It is connected at its dorsal side by a small inferior descending canal with the top of the stem (*aa*), and by a small superior ascending canal with the oleocyst (*co*). The somatocyst is twice as broad and half as long as the nectosac (*w*). The oleocyst (*co*) is a small cæcal process filled by an oil-globule, and is nearly in contact with the middle of the coryphal crest (*nk*).

Basal Nectophore (fig. 1, ventral view; fig. 2, dorsal view; fig. 3, lateral view from the right hand; fig. 4, from the left hand side).—The second nectophore (also called the distal, posterior, inferior or basal nectocalyx), is four times as long and twice as broad as the first, and of a very different form. It is in general a slender, pentagonal, truncate pyramid, the five edges of which are asymmetrically developed and somewhat spirally twisted. The ground-form is internally (with respect to the four radial vessels of the nectosac) quadriradial; externally (with respect to the five edges of the exumbrella) quinqueradial; and at the same time bilateral, with respect to the sagittal plane, which divides the body into right and left halves, and is determined by the ventral position of the hydrœcial canal, and the dorsal position of the nectosac (*w*).

The five edges of the truncate pyramid are more or less wing-like, prominent, and finish at the distal end in five triangular pyramidal teeth; they are elegantly denticulate in the lower third, and twisted in a deltoidal (or right-hand ascending) spiral. Their development is unequal and asymmetrical. The odd dorsal edge (*nd*), which runs along the dorsal median line of the nectosac, is less prominent than the four others, which are paired. The broadest wing, and the strongest terminal tooth, are developed from the left ventral edge (n^3), and next to this from the right dorso-lateral edge (n^2); whilst the right ventral edge (n^4), and the left dorso-lateral edge (n^1) are smaller.

The two dorso-lateral edges (n^1, n^2) correspond to the two symmetrical lateral edges of a bilateral and quadriradial Medusa, whilst the two ventro-lateral edges are produced by the development of the hydrœcial canal on the ventral side of the second nectophore. This canal is not closed, but covered by the two broad wings which develop from the two ventro-lateral edges; the right of these (*nx*) is broader and overlaps the left (*nl*); their inferior free margin is dentate.

The truncate apical or proximal face of the second nectophore is obliquely bevelled, and bears a triangular apophysis, which enters into the hydrœcium of the first nectophore, and encloses the nectocalycine duct. The five edges are more equally developed at this superior end (fig. 10); a horizontal transverse section beyond it (fig. 11) demonstrates how the two ventro-lateral wings develop more strongly, and form the hydrœcial canal (*ui*). The differentiation of the five wings is strongest at the distal or inferior end.

The basal or distal face of the second nectophore (seen from below in fig. 12) exhibits

the opening of the nectosac (*uo*) surrounded by the velum (*v*), and at its ventral side the opening of the hydrœcial canal (*ui*). Near the velum arise two small lateral spines, which lie in the radius of the two much larger triangular teeth, being the distal prolongations of the two dorso-lateral edges (n^1 left, n^2 right).

Nectosac (figs. 1–4, w^2).—The subumbrella of the second nectophore is cylindrical and occupies its dorsal half. The nectocalycine duct, which comes from the top of the stem and enters into the subumbrella somewhat below its apex, divides into the four radial canals (*cd* dorsal, *cv* ventral, *cx* right, *cl* left). These descend vertically and nearly parallel to the ostium, where they are united by the circular canal.

Hydrœcial Canal.—The ventral groove of the second nectophore, which forms the continuation of the hydrœcium of the first, has an irregular form (figs. 10–12, *ui*, in transverse section). It is enclosed between the ventral wall of the second nectophore, and the two broad ventro-lateral wings which arise from it, the right (*ux*) overlapping somewhat the left (*ul*).

Siphosome (*as*).—The long stem, which may be retracted completely into the hydrœcial canal, bears a series of twenty to thirty or more *cormidia*. These are detached from the stem before they reach sexual maturity and swim freely about as *Aglaisma gegenbauri* (Pl. XL.). They are characterised by a cuboidal bract, which has a caudal prolongation at the inferior dorsal edge, and by four radial canals arising from the phyllocyst (two slender odd sagittal and two paired broad lateral). Compare on their structure, above p. 119.

Family VIII. DESMOPHYIDÆ, Haeckel, 1888.

Desmophyidæ, Hkl., System der Siphonophoren, **95**, p. 36.

Definition.—Calyconectæ polygastricæ, with a biserial nectosome, composed of four to six or more opposite nectophores. Cormidia ordinate, eudoxiform or ersæiform, separated by equal free internodes; each siphon with a bract.

The family Desmophyidæ, represented by two new genera only, is of special interest as a connecting link between the preceding (VII.) and the following family (IX.). It agrees in general structure and composition with the Diphyidæ, but differs from them in the greater number of nectophores which are arranged in a biserial nectosome. This latter character is also found in the Polyphyidæ, which, however, differ in the absence of bracts. The Desmophyidæ may be derived immediately from the Diphyidæ, by multiplication of the nectophores. The Polyphyidæ may have arisen from the former by reduction and loss of the bracts.

Two genera only of Desmophyidæ have been observed by me, each with a single species. Both agree in the form of the rounded edgeless nectophores and bracts with the

Prayidæ, and are probably derived from this subfamily of Diphyidæ. The two genera of the former correspond to those of the latter.

Desmalia, the first genus, is in general appearance very similar to *Praya* (Pls. XXXI., XXXII.), and possesses, like it, eudoxiform cormidia. Each eudoxome is composed of two medusomes, a sterile and a fertile. The sterile medusome exhibited in the only species observed nearly the same shape as that of *Praya galea*, figured in Pl. XXXII. The cavity of the helmet-shaped bract contained a single siphon with a tentacle, and on the ventral side of the former a single gonophore with a well-developed umbrella. All gonophores of the single specimen observed were female. The corm of *Desmalia* may be, therefore, dioecious.

Desmophyes, the second genus, is described in the sequel (Pl. XXX.). It is in general composition and special structure very similar to *Lilyopsis*, and possesses, like this Prayid, ersæiform cormidia. Each ersæome is composed of two sterile and one or several fertile medusomes. The first sterile medusome consists of a bract (an umbrella with four radial canals), a manubrium (siphon), and a tentacle. The second sterile medusome is represented by a well-developed "special nectophore," a medusiform umbrella with four radial canals and a ring canal, muscular subumbrella and velum, but without manubrium. The umbrellar margin of this Medusa was beset (in the only species observed) with a corona of rudimentary tentacles and ocelli (almost as in some species of *Lilyopsis*). The group of sexual medusomes was represented by several clustered fertile gonophores; one large, and a number of small vicarious buds. The corm was monœcious and diclinic, the cormidia alternately males and females.

The development of the Desmophyidæ is not known; but it will probably be found to be hypogenesis, the gonophores ripening whilst sessile on the stem; as is also the case in the closely allied Polyphyidæ.

Synopsis of the Genera of Desmophyæ.

Cormidia eudoxiform, composed of two medusomes (one sterile and one fertile), without special nectophore,	32A. *Desmalia.*
Cormidia ersæiform, composed of three or more medusomes, with a special nectophore,	32B. *Desmophyes.*

Genus 32A. *Desmalia*,[1] n. gen.

Definition.—Desmophyidæ with rounded edgeless nectophores, arranged in a biserial nectosome. Cormidia without special nectophores.

The genus *Desmalia* is represented by a polygastric Calyconect, which is in general very similar to the common forms of the well-known genus *Praya*, but differs from

[1] *Desmalia* = Marine chain, δέσμος, ἅλιος.

them in the possession of numerous (four to six or more) nectophores, arranged in a biserial nectosome similar to that of *Hippopodius* and *Polyphyes*.

A single specimen only of this genus was captured by me during my voyage through the Indian Ocean, between the Maldive Islands and Socotra, in March 1882. But unfortunately it was injured during capture, and decomposed before I could make a sketch of it. The general appearance and the form of nectophores and bracts were similar to the figure which Fewkes published in 1880 as "the young of *Praya cymbiformis*."[1] But instead of two opposite nectophores there were four present, the superior pair somewhat smaller than the inferior. The cormidia, fifteen to twenty or more, succeeded on the stem of the siphosome nearly without intervals, so that the helmet-shaped bracts covering one another formed a continuous series of scales, whence I called this species provisionally *Desmalia imbricata*. A fragment of a similar siphosome was found in a bottle from the Challenger collection, taken in the South Pacific (Station 165). The structure of the cormidia, and mainly the form of the helmet-shaped bract (with four radial canals), was similar to that of *Praya galea* (Pl. XXXII.). Each eudoxiform cormidium contained on the ventral side of the siphon a single gonophore with well-developed umbrella and a small ovarium. All the cormidia were female.

Genus 32B. *Desmophyes*,[2] Haeckel, 1888.

Desmophyes, Hkl., System der Siphonophoren, p. 36.

Definition.—Desmophyidæ with rounded edgeless nectophores, arranged in a biserial nectosome. Each cormidium provided with a small special nectophore.

The genus *Desmophyes* is closely related to the preceding *Desmalia*, but differs from it in the possession of a special nectophore on each cormidium, and by the reduction of the umbrella of the gonophores. It agrees in these characters with *Lilyopsis*, and has the same relation to this Diphyid genus as *Desmalia* bears to *Praya*.

The only species of *Desmophyes* which I observed, and which is described in the sequel, agrees with some species of *Lilyopsis*, not only in the general composition of the cormidia, but also in the special form of their component parts. The special nectophore of each cormidium bears on the margin of the medusiform umbrella a number of ocelli and a corona of rudimentary tentacles (almost as in *Lilyopsis medusa*, &c.). Whilst the subumbrella is strongly developed in these special nectophores, it is reduced in the gonophores, which possess a long prominent manubrium. Each cormidium has a number of buds besides the mature gonophore.

[1] *Bull. Mus. Comp. Zoöl.*, vol. vi. No. 7, p. 146, pl. iii. fig. 2.

[2] *Desmophyes*=Chain-like animal, δέσμος, φύης.

Desmophyes annectens, n. sp. (Pl. XXX.).

Habitat.—Indian Ocean, south coast of Ceylon, December 1881 (Haeckel).

Nectosome (fig. 1).—The swimming column was composed, in the only specimen observed, of six nectophores arranged in two opposite series. The two uppermost nectophores were half as large as the two lowermost, and the two bells of the second pair placed between them, intermediate in size. Each of the two largest inferior nectophores had a length of 15 mm. and a breadth of 10 mm., and the entire biserial nectosome was about 30 mm. long and 18 mm. broad.

Nectophores.—The swimming-bells are on the whole very similar to those of *Praya galea*, their jelly soft and delicate, the surface smooth and rounded, without edges. The form is obliquely campanulate or mitriform, the apical part rounded, the basal part with the ostium obliquely truncate.

The dorsal (outer or abaxial) face of each nectophore is convex and smoothly rounded, as is also the lateral face. The ventral face, however (turned to the common axis of the stem), is concave and forms two parallel, longitudinal, prominent wings, which embrace a hemicylindrical groove. The ventral grooves of each two opposite nectophores are so fitted one into another that they form together a cylindrical canal. This axial tube, tapering towards the apex; is the hydrœcial canal, which encloses the superior part of the common stem; the contracted siphosome may be partly retracted into it.

Each nectophore is attached to the common stem by means of a short pedicle, a vertical triangular lamella, which arises by a broad base from the upper third of the ventral groove, and is fixed at its apex to the uppermost part of the stem. The pedicle encloses the peduncular canal which connects the stem-cavity with the nectosac.

Nectosac.—The inferior basal or distal half of each nectophore is occupied by the muscular subumbrella, which has an obliquely campanulate form. Its basal mouth is wide, and surrounded by a broad velum. The four radial canals of the subumbrella are of different lengths, the two lateral canals (right and left) being larger than the ventral (or axial) canal, and smaller than the dorsal (or abaxial) canal. They unite at the base of the velum by a circular marginal canal, and this is beset with eight red pigment spots or ocelli, similar to those in the special nectophores of the cormidia. Four of them are placed perradially (at the distal end of the four radial canals) and four others interradially (between the former). There are no rudimentary tentacles on the margin of the umbrella; these are peculiar to the special nectophores.

The superior, apical or proximal, half of the nectophore contains two canals which are placed in its sagittal plane. The peduncular canal, which arises from the canal of the common stem in its uppermost part, enters by the triangular pedicle of the nectophore in its jelly-substance, and descends obliquely in a curve towards the apex of the subumbrella,

where it divides into the four radial canals. From the proximal base of this pedicular canal arises a blind pallial canal, which ascends towards the dorsal median line of the exumbrella, and ends near its apical part by a small cæcal diverticulum (just as in *Lilyopsis*). There is no inferior or descending pallial canal, as in *Praya*.

Siphosome.—The long tubular stem of the cormus, which proceeds from the basal opening of the hydrœcial canal (between the two lowermost nectophores), is beset in its upper part with numerous buds of cormidia, and bears in its lower part a series of fully developed sexual cormidia, separated by equal free internodes; their number in the specimen observed was about a dozen. Male and female alternate regularly.

Cormidia.—Each cormidium is essentially composed as in *Ersæa*, of at least three different medusomes; firstly, a sterile medusome composed of a bract, a siphon, and a tentacle; secondly, a special nectophore; and thirdly, a male or female gonophore; the latter bears a number of similar buds or reserve gonophores at its base. The entire composition of the cormidia is very similar to those of *Lilyopsis*. The subumbrellar cavity of the bract covers the greater part of the other organs; these are placed as usual, so that the siphon and its tentacle occupy the dorsal part of the cavity, the special nectophore the ventral part, and the gonophores lie between them on both sides.

Bracts (fig. 2*b*, from the right side; fig. 3*b*, from the left side).—The covering scales of the cormidia, bracts or hydrophyllia, are very similar to those of *Praya*. They have the form of a flat cap or an overturned boat, and are about 10 mm. long by 5 mm. broad. Their ground-form is bilateral, more or less asymmetrical, their surface smooth, with rounded edges. The upper convex face is compressed from both lateral sides; the lower face contains a deep irregular subumbrellar cavity, in which the organs of the cormidium are partly hidden. The jelly-substance of the umbrella is much thicker in the ventral than in the dorsal part of the bract; it is thinnest on both lateral sides, which are deeply cleft in the middle.

Through the base of this deep lateral fissure passes the common stem of the siphosome (*a*). The axial canal of this latter gives off a short branch to each bract, which forms near the point of its attachment a small pyriform diverticulum (*bc*). From the base of this phyllocyst arise four radial canals, which enter into the jelly-mass of the bract, are irregularly bent, and end in a vesicular diverticulum. Two of these four canals are odd, and lie in the oblique sagittal plane of the bract, a shorter ventral (*cv*) and a longer dorsal (*cd*); the two others are paired lateral canals, and enter into the dorsal lobes of the bract (right *cx*, and left *cl*).

Siphons (figs. 2, 3, *s*).—The single polypite, which occupies the dorsal part of each bract-cavity, has the usual form of siphons in Calyconectæ. A thick-walled ovate basigaster (*sb*) is connected by a short pedicle with the common stem (*a*). The large ovate or pyriform stomach exhibits in its wall eight distinct orange-coloured liver-stripes

(*sh*). The contractile and very mobile proboscis (*sr*) terminates in a suctorial mouth, the margin of which sometimes is regularly octolobate (fig. 3, *ss*).

Tentacles (figs. 1, 2, 3, *t*, 8).—The single tentacle which arises from the pedicle of each siphon in the most dorsal part of the bract-cavity is of the form usual in Calyconectæ. It is very long and contractile, and beset with very numerous equidistant tentilla. Each of the latter (fig. 8) bears on its pedicle an elongated reniform cnidosac (*tk*), and this contains on each side of the cnidoband (*km*) a group of six to eight large ensiform cnidocysts (*kl*). The pedicle (*tt*) as well as the terminal filament (*tf*) is inflated and vesicular at the distal end.

Special Nectophores (figs. 2, *nn*, 6).—The special nectophore of each cormidium, which is placed in the ventral part of the bract-cavity, offers in *Desmophyes* a most interesting medusiform structure, similar to that of *Lilyopsis*. The umbrella is bilaterally symmetrical, since its jelly-mass is more developed in the dorsal than in the ventral part; it arises by a conical pedicle, which fits into the apex of the bract-cavity. The pedicular canal, which arises from the common stem, does not enter into the apex of that pedicle, but into the middle of its dorsal edge (fig. 6, *cp*).

The subumbrella of the special nectophore (*w*) is hemispherical, occupies its basal half and opens by a wide mouth, surrounded by a broad velum (*v*). The four radial canals (*cr*), which arise from its apex, are united at its margin by a circular canal (*cc*). The margin of the umbrella, beyond the latter, is beset with eight red pigment spots or ocelli (*uy*), four of these lie perradially (at the distal end of the radial canals), four others in the middle between them. They are relatively larger than in the main nectophores. Besides, the margin of the umbrella is beset with a corona of sixteen short tentacles (*t*); eight placed beyond the ocelli, and eight others alternating with these, between the former.

Gonophores (figs. 2, *f*, 4, 5).—*Desmophyes* is monœcious and diclinic, both sexes alternating so regularly that each cormidium has gonophores of one sex only, and two neighbouring gonophores always being of different sexes, forming together a pair. Each cormidium bears only one fully-developed gonophore; but at its base are placed the buds of several reserve gonophores. They lie between the dorsal siphon and the ventral special nectophore.

Androphores (fig. 4).—The male gonophores exhibit, fully developed, a very large, spindle-shaped manubrium (*hm*), with a cylindrical central spadix (*hx*); it is widely prominent from the cavity of the small retracted umbrella (*u*); the latter envelopes only the base of the former, but exhibits four distinct radial canals (*cr*) and a uniting circular canal (*cc*).

Gynophores (figs. 2, *f*, 5).—The female gonophores have a campanulate umbrella (*f*) larger than that of the males, also with four well-developed radial canals (*cr*) and a connecting circular (*cc*). The cavity of the subumbrella in ripe females is filled by a large pyriform or subglobular manubrium, which contains usually four large ovules of equal size, disposed in form of a cross (*o*).

Family IX. POLYPHYIDÆ, Chun, 1882.

Polyphyidæ, Chun, **86**, p. 12.
Hippopodidæ, Kölliker, **4**, p. 28.

Definition.—Calyconectæ polygastricæ, with a biserial nectosome, composed of four to six or more opposite nectophores. Cormidia ordinate, separated by equal free internodes, always without bracts.

The family Polyphyidæ differs from the other polygastric Calyconectæ in the complete absence of bracts. The nectophores are numerous, and arranged in a biserial nectosome, as in the preceding Desmophyidæ, from which they may be derived by the reduction of the bracts. The general composition of the cormidia, as well as the special structure of the single parts composing them, is very similar to that of the other Calyconectæ (mainly Prayidæ); but in some respects they approach more to the Physonectæ.

The oldest and best known form of Polyphyidæ is the common Mediterranean *Hippopodius gleba*, described and figured so early as 1775, by Forskål, under the name *Gleba hippopus* (**11**, pl. xliii. fig. E). It has been mentioned under very different names by later authors (compare **33**, p. 22). The first accurate anatomical description of it was given in 1853 by Kölliker (**4**), others by Vogt (**6**) and Leuckart (**8**). Kölliker observed a second Mediterranean form of this family, which he called *Vogtia pentacantha* (**4**, p. 31, Tab. viii.); and he established for these two genera the family Hippopodidæ, differing from the Physophoridæ in the absence of a pneumatophore, from the Diphyidæ in the possession of numerous nectophores arranged in a biserial nectosome similar to that of the Agalmidæ. Chun afterwards (1882) called the same family Polyphyidæ (in opposition to Diphyidæ and Monophyidæ). Leuckart united the Hippopodidæ and Diphyidæ in his group Calycophoridæ (**8**).

Nectosome.—The nectophores of the Polyphyidæ are always numerous, at least four to six, often eight to twelve, sometimes more. They are constantly opposed in alternate pairs and arranged in a biserial column, similar to that of the Agalmidæ. But a remarkable difference exists in the form and the structure of the trunk. The tubular trunk or common stem of the nectosome, which bears the nectophores, is, in the Agalmidæ, Apolemidæ, and other Physonectæ, the rectilinear prolongation of the trunk of the siphosome, which bears the siphons and gonophores; the former is the superior and the latter the inferior part of a straight, cylindrical tube. Quite different is the relation of the two parts of the trunk in the Hippopodidæ, as was first pointed out by Leuckart.[1] The superior part of the common stem, or the trunk of the nectosome, is connected with the inferior part, or the trunk of the siphosome, at a small acute angle, which forms the top of the corm. Both descend together from the top, and the deflexed trunk of the nectosome, bent down upon itself, forms a spiral band which surrounds the

[1] **8**, p. 303, Taf. xii. fig. 3; **35**, p. 553, Taf. xlvii. fig. 27.

trunk of the siphosome in wide spiral turnings. Hence, it appears as though the axis of the cone formed by the nectophores was only a lateral branch of the upper end of the cœnosarc; but in reality the upper part of the latter is deflexed and turned around the lower part. The youngest and smallest nectophores, therefore, are placed at the uppermost part, the oldest and largest at the lowermost part of the nectosome. The point of vegetation of the former is very near to that of the siphosome, but separated from it by a small interval (Pl. XXIX. fig. 7, *x*. Compare **35**, p. 553, Taf. xlvii. fig. 27, *ab*).

Nectophores.—The nectocalyces of the Polyphyidæ appear in two different forms, which are characteristic of the two subfamilies of this family. The Hippopodidæ (*sensu stricto*) have smooth nectophores, similar to a horse-shoe, with rounded surface (*Hippopodius* and *Polyphyes*, Pl. XXIX. figs. 1–8); they may be derived from the Prayidæ. The Vogtidæ, on the other hand, represented by the genus *Vogtia* (figs. 9–14), have pentagonal nectophores with angular surfaces; they may be derived from the Diphyopsidæ. The fundamental form is always bilaterally symmetrical, a deep ventral groove dividing the nectophore into two equal halves. The jelly-substance is very voluminous and usually hard, cartilaginous; the nectosac is relatively very small and more or less rudimentary.

The special form and the arrangement of the nectophores in alternately opposite pairs are very peculiar. That part of the nectophore which bears the circular opening of the nectosac must be regarded, of course, as the basal part. Opposite to this is the apical part, or the true pedicle of the nectophore, a small triangular lamella, by which it is attached to the common stem. This pedicle arises in the sagittal plane of the nectophore, midway between the two parallel ventral wings, which include the deep concave ventral groove. Strictly speaking, only the vertical inferior half of this axial groove, beyond the pedicle, represents the ventral side, whilst its superior half, above the pedicle, belongs to the dorsal side. The outer or abaxial part of this latter forms the free convex dorsal face of the nectophore, which ascends more or less vertically in the lateral profile view of the nectosome. Each nectophore embraces with the two lateral wings of the ventral groove the adjacent parts of two other (superior) nectophores; with the descending ventral part of the wing the same part of the opposite nectophore, and with the ascending dorsal part of the wing the basal part of the superjacent nectophore of the same side. An important consequence of this peculiar arrangement is, that the openings of the nectosacs become hidden and nearly closed by the uppermost covering part of the subjacent nectophore; only the openings of the two lowermost (oldest and largest) nectophores lie quite open, and are not covered.

Nectosac.—The swimming cavity in the nectophores of the Polyphyidæ is very small, flat, and reduced, and the muscle-plate of its subumbrella very thin; the power of swimming therefore very weak. Indeed these Calyconectæ swim more slowly than any of the other groups of this order. The velum, too, which surrounds the wide opening of the nectosac, is very small, usually crescentic or sickle-shaped, broader in the dorsal

(superior or abaxial) half than in the rudimentary ventral (inferior or axial) half. The wide opening or ostium of the flat nectosac is sometimes circular, at other times reniform or even cordate, notched by a deep incision in the middle of the ventral margin. Usually two strong ventral teeth (or the lowermost apophyses of the two lateral wings) are prominent over both sides of that notch.

Canals of the Nectosac.—The subumbrella of the nectophores possesses in the Polyphyidæ, as in all other Siphonophoræ, four radial canals, united by a marginal ring-canal above the velum. But they are here peculiarly differentiated. The pedicular canal of each nectophore, which arises from the tubular stem and runs through the lamellar pedicle, is short and divides in the middle of the ventral groove into two branches, an ascending and a descending. The ascending branch is a simple blind pallial vessel (corresponding to the superior mantle-canal of *Praya*); it runs in a radial direction, inside the jelly-mass of the nectophore, towards its outermost and uppermost dorsal angle (between the median line of the ventral groove and the dorsal side of the nectosac). The descending branch runs to the top of the subumbrellar cavity, and divides here into four very unequal branches or radial canals. The median dorsal and the two paired lateral canals are very short, and soon open into the marginal canal. The median ventral canal, however, is very long and dilated towards the margin of the umbrella; it forms here a flat sinus or diverticulum, the form of which is very characteristic of the individual species (sinus ventralis, *cv''*, figs. 3, 4, 13, 14). It is elliptical or ovate in *Hippopodius gleba*, hexagonal in *Polyphyes ungulata*, two-winged in *Vogtia köllikeri*, &c. The cells of the entoderm, which line the flat and broad cavity of this ventral sinus, are very large, polygonal, and filled with peculiar fine granules. The narrow intervals between the single cells have been described by Claus as "peculiar ramifications of the vessel" (**35**, p. 553).

Siphosome (fig. 1).—In the Polyphyidæ the trunk of the siphosome, or the common stem which bears the cormidia, is usually contracted and retracted into the hydrœcial cavity of the nectosome. But in the expanded state, and protruded through the basal opening of that cavity, it is a rather long tubular stem, two, three, or more times as long as the nectosome. The number of cormidia is sometimes small, four to eight, at other times much larger, twenty to thirty or more; besides the numerous buds of young cormidia, which are found in a crowded ventral series along the uppermost part of the siphosome (Pl. XXIX. fig. 7, *is*).

Cormidia.—The groups of polymorphous persons, which cover the trunk of the siphosome, differ from those of all other polygastric Calyconectæ in the complete absence of bracts. This may be explained either by total reduction and loss of the hydrophyllia (perhaps in correlation with the development of the large nectosome and its peculiar hydrœcial cavity), or by a phylogenetic dislocation of organs which were originally connected. It is possible, that in older ancestral forms of this family, the

umbrellæ of the sterile medusomes were separated from the appertaining siphons, and both so dislocated, that the former migrated upwards and together composed the nectosome; whilst the manubria with the tentacles remained in the cormidia, composed of clustered sexual medusomes or gonophores.

The cormidia of the Polyphyidæ are ordinate and monogastric, as in all other Calyconectæ, separated by free internodes of the stem, of equal length. Each cormidium contains a single siphon and one tentacle, besides a group of clustered gonophores. These are sometimes of one sex in each cormidium, so that this is diclinic. The corm itself is monœcious, male and female cormidia occurring on the same stem; usually the androphores occupy the lower or distal part, the gynophores the upper or proximal part of the siphosome. At other times the cormidia are monoclinic (composed of gonophores of both sexes) as described by some authors (Kölliker, **4**, and Weismann, 1883, p. 194).

The general rule, that the cormidia are ordinate in all polygastric Calyconectæ, has perhaps a single exception in *Polyphyes*. The clustered gonophores are here separated from the base of the siphon by a small interval, and this seems to become larger in some species, so that the cormidia may be described as alternate (or even irregular), the sterile medusomes (siphon and tentacle) alternating with the fertile (gonophores), just as in many Physonectæ (*Agalma*, *Agalmopsis*, &c.). This is perhaps the case in the Mediterranean form described by Kölliker as *Hippopodius neapolitanus* (**4**, Tab. vi.), and in a similar South Atlantic form, an incomplete specimen of which I observed in a bottle from the Challenger collection (from Station 325), and which I have called provisionally *Polyphyes dissolutus* (**95**, p. 36). The preservation of this fragment, however, was not sufficiently good to furnish confirmation of that statement, and since the description of Kölliker has not been confirmed by later authors, it may be that an accidental error occurred, and that the cormidia are always ordinate as in the common *Hippopodius*.

Siphons (fig. 1, *s*).—The polypites of the Polyphyidæ are in general of the same shape as in the other Calyconectæ. The pedicle arising from the siphosome is sometimes longer, at other times shorter or even rudimentary. The basigaster is subspherical or ellipsoidal, its thickened exoderm full of cnidocysts. It is separated by a pyloric valve from the ellipsoidal or spindle-shaped glandular stomach, which passes over without a sharp boundary line into the long and very contractile proboscis. Sometimes these parts are very prolonged and vermiform. The distal mouth is small and simple, but may be expanded in the form of a circular suctorial disc.

Tentacles (fig. 1, *t*).—The single tentacle, which is attached to the base of each siphon, is very long and thin, beset with a series of very numerous tentilla. Each tentillum (fig. 8) is composed of a long pedicle, a roundish cnidosac, and a cylindrical terminal filament; the latter is often coiled up spirally. The cnidosac is relatively small, ovate, ellipsoidal or subspherical, often coloured by yellow or orange pigment. Its cnido-battery is placed in form of a curved band along the convex dorsal side of the cnidosac, and

composed of innumerable small paliform cnidocysts; on each side of it lies a bunch of a few large ensiform cnidocysts (usually four to eight, rarely more).

Gonophores.—The sexual medusomes of all Polyphyidæ come to maturity whilst sessile on the stem. There is, therefore, in this family no true metagenesis, as in the Diphyidæ and Monophyidæ. The cormidia are sometimes diclinic (*Hippopodius*), at other times monoclinic (*Polyphyes* and *Vogtia*). Usually the gonodendra are small, and only one or two large mature gonophores exist between a small number of immature and young buds. Usually in the diclinic corms the female gonophores occupy the superior, the male gonophores the inferior part of the siphosome. The gonophores of both sexes have a well-developed, hemispherical or campanulate umbrella, with four radial canals and a connecting ring-canal above the small velum. The manubrium, from the exoderm of which the sexual cells are developed, is ovate, spindle-shaped or cylindrical; it becomes very large and widely protruded through the ostium of the subumbrella, often two to four times as long as the latter, or even more. Thus the form of the gonophores in the Polyphyidæ is more like that in the Physonectæ than in the other Calyconectæ.

Synopsis of the Genera of Polyphyidæ.

I. Subfamily HIPPOPODIDÆ. Nectophores rounded, not prismatic.	Ostium without teeth, cormidia diclinic,	33. *Hippopodius.*
	Ostium with six teeth, cormidia monoclinic,	34. *Polyphyes.*
II. Subfamily VOGTIDÆ. Nectophores five-sided, prismatic.	Ostium with five teeth, cormidia monoclinic,	35. *Vogtia.*

Subfamily HIPPOPODIDÆ.

Genus 33. *Hippopodius*,[1] Quoy and Gaimard, 1827.

Hippopodius, Quoy and Gaimard, Ann. d. Sci. Nat. (Zool.), t. x.

Definition.—Polyphyidæ with rounded horseshoe-shaped nectophores, the ostium of which is smooth or slightly lobate. (Cormidia diclinic. Gonophores attached to the base of the siphons.)

The genus *Hippopodius* is the most common of the three genera of Polyphyidæ, and is represented by the well-known Mediterranean type *Hippopodius gleba*, and by several similar species, which are widely distributed over all warmer seas. I found single detached nectophores of it in different bottles in the Challenger collection, taken in the Tropical Pacific and Atlantic; and also in the collection of Captain Rabbe, from the Indian

[1] *Hippopodius* = Horse-shoe, ἵππος, πόδιον.

Ocean. They differ in size and form, and especially in the shape of the basal face and the ventral sinus, more or less from the Mediterranean species, but were not sufficient for the definition of distinct species. To enable this, a further accurate examination and comparison of the entire corm, from different localities, is required.

The most accurate description of the Mediterranean *Hippopodius gleba* (=*Hippopodius luteus*, Vogt, **6**, very common on the Riviera) is given by Leuckart.[1] It differs somewhat from similar forms taken in other parts of the Mediterranean. That form which Kölliker has described as *Hippopodius neapolitanus* from Messina (=*Elephantopus neapolitanus*, Lesson, **3**) seems to belong to the following genus, *Polyphyes*. The mouth of the nectosac is surrounded in the latter by six prominent teeth (four dorsal and two ventral), whilst it is smooth and toothless in *Hippopodius*. Another important difference between these two genera seems to be found in the composition of the cormidia. The clustered gonophores are diclinic, and attached to the base of the siphon in *Hippopodius*, whilst they are monoclinic and separated from it by a small interval in *Polyphyes*. Both genera together make up the subfamily Hippopodidæ.

The striking contradictions between various authors, respecting the sexual organs of *Hippopodius*, can be explained only by the assumption that these two similar genera have been confounded. The description which Leuckart has given of the diclinic cormidia of *Hippopodius gleba* (**8**) is as correct as that which Kölliker has given of the monoclinic cormidia of *Hippopodius neapolitanus* (**4**). The accuracy of these latter observations has been confirmed recently also by Weismann, in his work on Die Entstehung der Sexual-Zellen bei den Hydromedusen (1883, p. 194). He found in each cormidium associated a single female and two male gonophores. Perhaps these differences in the composition of the cormidia of the two genera are more important than those in the form of their nectophores.

Genus 34. *Polyphyes*,[2] Haeckel, 1888.

Polyphyes, Hkl., System der Siphonophoren, p. 36.

Definition.—Polyphyidæ with rounded horseshoe-shaped nectophores, the ostium of which is surrounded by six prominent apophyses. (Cormidia monoclinic. Gonophores separated from the base of the siphons.)

The genus *Polyphyes* differs from the preceding closely allied *Hippopodius* as well in the form of the nectophores as in the composition of the cormidia. The nectophores have in general the same horseshoe-shape as in *Hippopodius;* but in this latter their dorsal face is equally convex and smooth, and passes over into the lateral faces without a sharp edge. In *Polyphyes* their dorsal face is nearly quadrangular, and separated by two lateral parallel smooth edges from the lateral faces; further, the basal edge of their

[1] **8**, pp. 299–309, Taf. xii. figs. 1–4.

[2] *Polyphyes*=Animal with numerous buds, πολυφύης.

dorsal face, or the dorsal circumference of the ostium, is provided with four descending lobes or triangular teeth, which are wanting or but slightly indicated in *Hippopodius*. The two basal apophyses of the lateral ventral wings are also more prominent than in the latter, and the mouth of the nectosac therefore surrounded by six teeth. The general form of nectophores in *Polyphyes*, therefore, is intermediate between that of *Hippopodius* and of *Vogtia*. Another difference seems to be indicated by the monoclinic cormidia and the position of the gonophores, which are attached to the base of the siphons in the two latter genera, separated from it by an interval in *Polyphyes*. (Compare the preceding description of *Hippopodius*.)

The typical species of this genus, described in the sequel, was observed by me in 1866 in the Canary Islands, and detached nectophores of it found again in the Challenger collection (Station 352, Tropical Atlantic). The characteristic form, however, of the nectophores, with the six strongly prominent teeth, figured in Pl. XXIX., is more developed in the specimens from Station 352 than in those which I observed myself in Lanzerote. These latter approach more to the southern Mediterranean form described by Kölliker as *Hippopodius neapolitanus* (4).

Polyphyes ungulata, n. sp. (Pl. XXIX. figs. 1–8).

Habitat.—Tropical and Subtropical Atlantic; Station 352, April 13, 1876; lat. 10° 55′ N., long. 17° 45′ W. Surface.

Canary Islands, Lanzerote; December 1866 and January 1867 (Haeckel).

Nectosome (fig. 1).—The swimming column is composed of five or six pairs of obliquely opposed nectophores, the size of which increases from the rounded top towards the bevelled base. The general outline of the compressed nectosome is ovate seen from the broad side, more lanceolate seen from the narrower side. The connection of the united nectophores is very firm, each embracing the base of the superjacent nectophore by the two lateral wings of its ventral groove; and also the opposite basal apophyses of the opposite superior nectophore.

Nectophores (figs. 1, 2, lateral view; fig. 3, apical view; fig. 4, basal view; fig. 5, ventral view; fig. 6, dorsal view).—The largest nectocalyces have a diameter of 15 to 20 mm., and possess the form of an inverted horse's hoof, the lower face of which is turned upwards. Five faces may be distinguished in the wedge-shaped horse-shoe, which represents an obliquely bevelled segment of a cone; an inferior basal face, an exterior dorsal face, an interior ventral face, and two paired lateral faces. The basal face, directed obliquely downwards and outwards, contains the reniform or subcircular mouth of the nectosac (figs. 3, *w*, 4) and the crescentic velum (*v*); it is surrounded by six prominent paired teeth, four dorsal and two ventral triangular apophyses; the two lateral dorsal

teeth are larger than the two median, and smaller than the two descending ventral teeth (fig. 4, *nx*, right; *nl*, left).

Exactly opposite to the basal face of the nectophores is the large axial or ventral groove directed obliquely upwards and inwards; it is limited by two prominent wings, the axial edges of the two paired lateral faces; these wings diverge towards the inferior (ventral) and more strongly towards the superior (dorsal) end of the axial groove, while they approach one another in the middle and at the dorsal corner of the groove (fig. 3). A small and thin triangular lamella, the pedicle of the nectophore, arises in its sagittal plane, in the middle of the axial groove, and is attached to the trunk of the nectosome by its axial apex. Strictly speaking, that part of the axial groove which lies below the pedicle is the ventral, and the opposite part, above the pedicle, the dorsal portion.

The dorsal or abaxial face of the nectophore (superior half of fig. 4) is a convex, vertical, nearly quadrangular plate, limited by four edges, and divided by three nearly parallel ridges into four oblong facettes. Each of these ends below in a triangular descending tooth; the two median teeth being smaller than the two lateral. The opposite superior edge of the dorsal face exhibits an odd median prominence and two smaller paired lateral (fig. 4, above).

The two paired lateral faces of the nectophore (right and left) are oblongish, convex, smooth (figs. 1, 2), and prolonged below into the two ventral teeth, which embrace the common stem of the nectosome. They are separated from the concave axial groove by the prominent edge of the lateral wing, from the convex dorsal face by the vertical lateral edge of the latter.

Nectosac (figs. 2–5, *w*).—The subumbrellar cavity, which occupies the bevelled basal face of the nectophore, is very shallow (fig. 2, *w*, in profile). Its wide ostium is subcircular, slightly reniform owing to a small median notch on its ventral side. The muscle-plate of the subumbrella is very thin and weak. The small velum (*v*) is sickle-shaped, rudimentary in the ventral half, broader in the dorsal half.

Canals of the Nectophores (figs. 2–4, *c*).—The nectocalycine duct passes from the trunk through the small pedicle of the nectophore directly towards the top of the subumbrella. Before reaching this, it gives off an odd long pallial vessel, which ascends obliquely in the jelly of the umbrella (immediately below the sagittal median line of the axial groove) and ends blindly near the dorsal apex of the nectophore (figs. 2–4, *ce*). The four radial canals, which arise from the top of the subumbrella and are united by the circular marginal vessel, are of very unequal length. The two paired lateral canals (right and left) are little longer than the short dorsal canal and ascend obliquely upwards, close to the latter. Much longer is the ventral canal (*cv*), which descends obliquely and before reaching the marginal canal expands in the form of a hexagonal or square ventral sinus (*cv''*). Its form is very characteristic of the species; it has six prominent corners, two median in the sagittal axis, two smaller ventral and two larger dorsal on both

sides; it occupies nearly the ventral half of the subumbrella. It is relatively three or four times as large as the small ovate or lanceolate ventral sinus of the common *Hippopodius gleba*. (Compare Leuckart, 8, Taf. xii. figs. 1, 2.)

Siphosome (figs. 1, 7).—The siphosome of *Polyphyes ungulata*, and its numerous appendages, are very similar to those of the well-known Mediterranean *Hippopodius gleba*, accurately described by Leuckart (8) and others. An important difference, however, seems to lie in the origin of the clustered gonophores, which are not attached immediately to the base of the siphons (as in the latter), but separated from them by a small interval. The cormidia, therefore, strictly speaking, are not perfectly ordinate, but more or less loose, since the loosely aggregated gonophores alternate with the single siphons. The number of the cormidia is very great in the largest specimens, up to twenty or twenty-five; besides the numerous small buds of developing cormidia, which are crowded at the top of the siphosome (fig. 7, *as*). The latter is separated from the top of the deflexed nectosome (*an*) by a small interval. The trunk of the nectosome is coiled spirally around the proximal portion of the trunk of the siphosome.

Siphons (fig. 1, *s*).—The polypites are in the expanded state about as long as a nectophore, and bear on a small pedicle a subspherical basigaster, followed by a long spindle-shaped stomach; this passes over into a long and narrow, very contractile proboscis, which opens by the terminal mouth. The mouth is often expanded in the form of a circular suctorial disc (fig. 1, *ss*).

Tentacles (fig. 1, *t*).—The capturing filament, attached to the pedicle of each siphon, is very long and bears a single series of equidistant tentilla. Each tentillum bears on a long pedicle, which is covered with papillæ (fig. 8, *tp*), a subspherical or ellipsoidal cnidosac, and attached to its base a long simple terminal filament (spirally coiled up in fig. 8, *tf*). The cnidosac contains a long, nearly annular cnido-battery, following its dorsal convexity, and composed of very numerous, small paliform cnidocysts (fig. 8, *km*); and on each side of it a paired lateral patch, composed of four very large ensiform cnidocysts (fig. 8, *kl*).

Gonophores.—Attached to the trunk, near the pedicle of the siphon, but separated from it by a small interval, are the monoclinic gonophores. Each cormidium bears in the superior part usually a single large female, in the inferior one or two male, gonophores, besides a small number of buds or younger forms. The male as well as the female gonophores have a well-developed umbrella with four radial canals and a ring-canal, and a large, widely prominent manubrium. That of the androphores (*h*), or the spermarium, is more oblong, spindle-shaped, and about twice as long as the ellipsoidal ovarium, or the manubrium of the gynophores (*f*). Usually one larger gonophore of each sex, with a very prolonged manubrium, is prominent from a group of smaller gonophores and of buds. The special structure of the gonophores is the same as in *Hippopodius gleba*. (Compare above, p. 178.)

Subfamily Vogtidæ.

Genus 35. *Vogtia*,[1] Kölliker, 1854.

Vogtia, Kölliker, Schwimmpolypen von Messina, p. 37.

Definition.—Polyphyidæ with pentagonal prismatic nectophores, the ostium of which is provided with five prominent apophyses. (Cormidia monoclinic. Gonophores attached to the base of the siphons.)

The genus *Vogtia*, established by Kölliker for the Mediterranean *Vogtia pentacantha*, differs from the two preceding genera mainly in the prismatic form of the pentagonal nectophores. Since this difference is similar to that between *Diphyes* and *Praya*, it perhaps justifies the distinction of two subfamilies: Vogtidæ (derived from Diphyidæ) with pentagonal exumbrella of the prismatic nectophores, and Hippopodidæ (derived from Prayidæ) with an edgeless exumbrella of the rounded nectophores. Probably the general composition of the nectosome as well as of the siphosome in *Vogtia* is similar to that in *Hippopodius*. But neither the first description of Kölliker (**4**), nor the supplementary remarks of Claus (**35**), and Keferstein and Ehlers (**33**), are sufficient to give a full idea of its anatomy. The last named authors have described a second species, *Vogtia spinosa*, from the coast of Brazil (**33**, p. 24). Similar to this are some scattered nectophores, which I found in the Challenger collection, taken in the South Atlantic (Station 326); they are here described as *Vogtia köllikeri*.

Vogtia köllikeri, n. sp. (Pl. XXIX. figs. 9–14).

Habitat.—Station 326, South Atlantic; March 3, 1876; lat. 37° 3′ S., long. 44° 17′ W. Surface.

Nectophores (fig. 9, lateral view, right side; fig. 10, oblique lateral view, half dorsal, half right side; fig. 11, basal view of a younger, fig 12, of an older nectophore; fig. 13, ventral view; fig. 14, dorsal view).—The nectocalyces have a cartilaginous consistence, vitreous aspect, and the general form of a flat pentagonal prism. The largest nectophore has a length of 6 mm., a height of 10 mm., and a breadth of 16 mm. The two large terminal faces of the prism are nearly parallel and pentagonal, an inferior (and abaxial) basal face, and a superior (or axial) apical face; this latter contains the broad ventral or axial groove, bounded by the two lateral wings. The five lateral faces of the prism are two paired dorsal, two paired ventro-lateral and an odd medio-ventral face; this latter is the smallest face and deeply bisected.

The basal face of the nectophore (fig. 11, of a younger, fig. 12, of an older specimen) contains in its middle part, nearer the axial side, the ostium of the nectosac (*w*); it is

[1] *Vogtia*, named in honour of Carl Vogt.

slightly concave, smooth, and probably directed (as in *Hippopodius*) obliquely downwards and outwards, in the vertical position of the axis of the nectosome. The opposite, almost parallel, apical face is also smooth, more concave, directed obliquely upwards and inwards; it contains the axial groove, which is limited by the two prominent lateral wings; it passes over downwards into the odd ventral face (fig. 13), which appears bisected by the lowermost part of the axial groove, limited by the two descending ventral teeth (the lowermost parts of the two axial wings).

The dorsal face of the nectophore (fig. 14) is convex, broad and depressed, and bisected by the prominent sagittal crest, which divides it into two paired lateral facettes, densely covered with conical spines (figs. 11, 12). Two strong paired frontal teeth, with a triangular spiny outside (fig. 9), separate the two dorso-lateral facettes from the two ventro-lateral; these are smaller, rather smooth, and separated one from another below by the smaller odd ventral face.

The five edges of the prismatic nectophore, which separate its five lateral faces, correspond to the four edges of the exumbrella of a bilateral Medusa. The odd dorsal edge, prominent in the sagittal median line of the dorsal face, is strongly dentate. The opposite ventral edge is divided by the lower part of the axial groove into the two ventral teeth, which embrace the stem. On both sides, to the right and left, are widely prominent the two triangular, strongly dentate, lateral apophyses which are placed at the opposite poles of the frontal axis; they separate the two dorso-lateral facettes from the two ventro-lateral faces, and correspond to the two lateral dorsal teeth of *Polyphyes*.

The numerous spines which cover the free outside of the nectophores (dorsal and lateral faces) are mammillate or flatly conical, with a small apical point. Their number amounts in each nectophore to more than a hundred.

Nectosac.—The subumbrellar cavity is very small, scarcely half as long and broad as the basal face of the nectophore, of which it occupies the axial or inner half (figs. 11, 12). Its wide ostium is reniform, with a deep median notch at the ventral side. The muscular plate of its shallow cavity is weak, the crescentic or sickle-shaped velum is rudimentary at the ventral side, more developed on the two lateral sides. The nectocalycine duct, which enters through the axial pedicle into the nectophore, gives off a blind pallial canal in its dorsal part (fig. 12, *ce*), and divides at the top of the nectosac into the four radial canals; three of these (the dorsal and the two lateral) are very short; the fourth (ventral) canal (*cv*) is long, and expands near the circular canal in form of a broad two-winged ventral sinus (figs. 11, 12, *cv''*). The concave dorsal edge of this sinus is smooth, whilst the convex ventral edge is much longer, and irregularly denticulate.

Order III. PHYSONECTÆ, Haeckel, 1888.
(Pls. VIII.–XXI.)

Physophoridæ, Eschscholtz, 1829, **1**, p. 139.
Physophoræ, Goldfuss, Auctt.

Definition.—Siphonophoræ with a pneumatophore and several nectophores (or instead of these bracts), without aurophore. Nectosome composed of a simple, apical, monothalamous pneumatocyst, and beyond it a biserial or multiserial group of nectophores, sometimes instead of these a corona of bracts. Siphosome always with numerous palpons, usually covered with numerous bracts. The trunk of the siphosome is either a single siphon (Monogastricæ) or a tubular or vesicular stem, bearing numerous cormidia (Polygastricæ). Each cormidium with a single siphon and a single tentacle, a group of palpons and gonophores. The cormidia are sometimes ordinate, at other times irregular.

The order Physonectæ, hitherto usually called Physophoridæ, comprises those very numerous and variously organised Siphonophoræ, which possess a nectosome composed of an apical pneumatophore and a group of nectophores. They agree in this combination with the following order Auronectæ, but differ from these as well in the absence of the aurophore as in the simple structure of the tubular trunk. Sometimes the nectophores are replaced by bracts; but these are also originally nectophores, with a reduced or lost nectosac. A further character common to all Physonectæ is the general presence of palpons or cystons; these are lacking in most other Siphonophoræ, with the exception of the Cystonectæ. The corm of the Physonectæ is rarely simple, and represents a single cormidium (in the monogastric Circalidæ and Athoridæ); usually it is composed of numerous cormidia, which are sometimes ordinate (with free internodia), at other times irregular (with scattered organs). The primary larva is always bilateral, and develops a pneumatophore very early (*Physonula*).

History.—The oldest descriptions and figures of Physonectæ are those of Forskål (1775), and relate to three Mediterranean forms, which he united in the genus *Physophora*—*Physophora hydrostatica*, *Physophora rosacea*, and *Physophora filiformis* (**11**). The first has been retained as the permanent type of the genus *Physophora;* the second was afterwards called by Eschscholtz (**1**) *Athorybia*, and the third *Epibulia;* this latter, however, is a *Rhizophysa*, and belongs to the Cystonectæ.

In the beginning of the present century the first observations on Physonectæ were made by Péron and Lesueur. In 1807 they published figures of *Physophora myzonema* and *Stephanomia amphitrites* (**14**, pl. xxix.). An excellent plate by Lesueur, with a splendid figure of *Stephanomia uviformis* (=*Apolemopsis uviformis*), was unfortunately never published. Afterwards a number of detached portions of Physonectæ, and fragments

of corms were described by Quoy and Gaimard (**2, 19, 20**) and by Lesson (**3, 22**); but their figures are so unnatural and incomplete, and their descriptions so superficial and devoid of scientific understanding of the subject, that they have only produced extraordinary confusion and numerous mistakes.

Eschscholtz, the founder of the System der Acalephen (1829), first established the family Physophoridæ, and distinguished it from the other two families of his Siphonophoræ (Diphyidæ and Velellidæ) by this definition:—"The soft body bears at its upper end a swimming-bladder filled with air." He distinguished (**1**, p. 141) ten different genera; three of these, however, belong to the Cystonectæ, and one to the Calyconectæ, so that six remain; of these, *Apolemia* and *Athorybia* are types of two separate families; *Agalma* and *Stephanomia* belong to the Agalmidæ; *Physophora* and *Discolabe* to the Discolabidæ. The system founded by Eschscholtz was much extended, but not advanced, by Lesson, who in his Acalèphes (1843) gave a most confused compilation of all descriptions published up to his time. Brandt (in 1835) founded the two families Agalmidæ and Anthophysidæ (**25**). The first good anatomical description of a Physonect was published in 1841 by Milne-Edwards, who illustrated the Mediterranean *Stephanomia* (= *Forskalia*) *contorta* (**71**). Another excellent paper on *Agalmopsis elegans* was written in 1846 by Sars (**27**, i.).

A more accurate knowledge of the peculiar organisation of the Physonectæ, and a more natural explanation of their complicated structure, was not acquired before the sixth decade of this century. At this time Kölliker (**4**), Vogt (**6**), Leuckart (**5** and **8**), Gegenbaur (**7** and **10**), and Huxley (**9**) so greatly advanced our knowledge by a series of excellent illustrations and accurate descriptions, that most succeeding observers have only been able to add single particulars. Claus, in his monographs of *Physophora hydrostatica* (**34**), *Halistemma tergestinum* (**74**), and *Agalmopsis utricularia* (**75**), advanced mainly our histological knowledge of the Physonectæ; as did afterwards, more especially, Korotneff (1884), but, unfortunately, without sufficient knowledge of their morphological and systematic relations (**50**).

My own observations on the Physonectæ were commenced in 1859 in Messina, and advanced much in 1866 during my residence at Lanzerote in the Canary Islands. I found here, and still more in 1881 in Ceylon, and during my voyage in the Indian Ocean, the opportunity of examining a number of interesting new forms and even new types of Physonects (*Circalia, Athoria, Dicymba, Crystallodes, Anthemodes, Lychnagalma, Nectalia, Discolabe*, &c., Pls. XI.–XXI.). The Challenger collection, however, contained only very few specimens of Physonectæ which were preserved well enough for description; only scattered fragments and detached parts (nectophores, bracts, siphons, gonophores) were found in many of the bottles.

Relying on these extended observations, and comparing the numerous scattered descriptions and figures of former observers, I was enabled to establish the new system

of Physonects, which I communicated to the Medicin. Naturwiss. Gesellschaft in Jena on July 8 and November 25, 1887 (95, pp. 38-42). I then gave the definition of twenty-five different genera (ten of which were new), and disposed them in eight families, four of which were new. Four families had already been distinguished by Huxley (9, p. 70), viz.:—(1) Apolemidæ; (2) Stephanomidæ (=Agalmidæ, Brandt); (3) Physophoridæ (*sensu restricto*); and (4) Athorybidæ (=Anthophysidæ, Brandt). The four new families of my system are—(1) Circalidæ; (2) Athoridæ; (3) Forskalidæ; and (4) Nectalidæ.

All authors up to this time have employed for this order the name Physophoridæ, given by Eschscholtz (1, p. 139). But this name has become unserviceable, since it is used with no less than four different meanings (95, pp. 38, 41). Huxley applies it to all Siphonophoræ, with the single exception of the Calycophoridæ (9, p. 67). The majority of authors employ the name in the sense of Eschscholtz, comprising not only our Physonectæ, but also the Cystonectæ (fifth order). Chun first separated the latter from the former, and proposed the term Physophoridæ for the first, and Pneumatophoridæ for the second (86, p. 1168). But, besides, the special family which I call Discolabidæ (XVI.) is generally named Physophoridæ. To avoid this general confusion, I propose for this order the name Physonectæ.

Nectosome.—The swimming apparatus is composed in all Physonectæ of an apical float or pneumatophore placed at the top of the trunk, and of a variable number of nectophores or swimming-bells, arranged in a variable manner around the trunk; rarely these nectophores are replaced by paddling bracts (Athoridæ, Anthophysidæ). The Physonectæ have therefore combined in their locomotive apparatus the active swimming-bells of the Calyconectæ and the passive hydrostatic float of the Cystonectæ and Disconectæ. They agree in this combination with the Auronectæ, but differ from these in the absence of the aurophore as well as in the simple tubular trunk and the structure of the siphosome. The physiological function of the two portions of the nectosome is very different; the hydrostatic float is comparable to the swimming-bladder of the fishes, and enables the Physonectæ to rise or descend; whereas the active movements of the nectophores, or the paddling bracts which these replace, effect the voluntary locomotion in every direction.

Pneumatophore.—The float filled with air, rising from the top of the axial trunk, is in all Physonectæ relatively small; much smaller than that of the Auronectæ and Cystonectæ; it rarely attains the size of a nectophore (Circalidæ); usually it is scarcely half as large, or less. Whilst the physiological importance of the float rests in its hydrostatic function (as "swimming-bladder"), its morphological nature is explained by its development; the pneumatophore is the modified umbrella of the original Medusa, the manubrium of which is the axial trunk (or the first siphon). (Compare above, p. 11.) Its form is usually ovate, spindle-shaped or pyriform, sometimes subspherical, at other

times cylindrical; it is more or less variable, and may be changed by the contraction of its muscular walls. The apex of the float is usually coloured by pigment (red or brown); sometimes this forms a regular octoradial star, with a colourless centre.

Pneumatosaccus.—Since the float is developed by an invagination of the original exumbrella,—comparable to a simple air-secreting gland of the exoderm (p. 12),—the central air-flask or pneumatocyst, filled with gas, is always surrounded by a double wall; the inner or invaginated wall (comparable to the entoderm of a gastrula) is the pneumatosaccus (or "Luftsack"), which secretes the structureless thin chitin-plate of the pneumatocyst; the outer or non-invaginated wall (comparable to the exoderm of a gastrula) is the pneumatocodon (or "Luftschirm"). The cavity between the two walls (cavum pneumatophoræ) is everywhere closed and filled with the nutritive fluid of the axial trunk, with which it communicates at its distal or basal end. This cavity is usually divided by a number of equidistant vertical septa into radial pouches, which correspond to those in the umbrella of a Medusa (*e.g.*, *Ægina*, *Cunina*). I find constantly eight radial pouches, regularly disposed around the pneumatosac, in the great majority of the Physonectæ; the number, however, is not quite constant; single individuals have seven or nine, instead of eight; some species (*Halistemma*, *Nectalia*) possess only four, other species twelve or sixteen. Sometimes the radial septa divide the whole cavity of the pneumatophore into chambers, at other times only its basal or inferior part; this remains simple in the Athoridæ and Apolemidæ, where no septa are developed.

Pneumatocyst.—The delicate chitinous air-flask, which is produced (as a cuticle) and immediately surrounded by the exodermal invaginated pneumatosac, seems to be closed in all Physonectæ at the apex (or the upper pole of its vertical axis); it is open at its thickened annular base (or the lower pole). This opening is the circular pneumatopyle or funnel aperture ("Trichterpforte," Chun, **48**, p. 512). It corresponds to an annular constriction of the surrounding pneumatosac, by which this is divided into two portions; the larger superior (or apical) portion alone secretes the chitinous plate of the flask; the smaller inferior (or basal) portion secretes no chitinous cuticle, and has a stratified exodermal epithelium of a peculiar shape and a yellowish or greenish colour; this is the important pneumadenia or the "air-funnel," which secretes the gas ("Lufttrichter," Chun, **48**, p. 512). The glandular epithelium of the pneumadenia often passes, owing to a secondary growth and further expansion, through the pneumatopyle into the cavity of the pneumatocyst and lines its basal portion—usually only one-fourth or one-third of its inner face ("secondary exoderm," Chun, **48**). The pneumadenia is then divided by the thickened chitinous ring of the pneumatopyle into a superior (endocystal) and an inferior (hypocystal) portion. At other times the pneumadenia gives off peripheral branches or lateral solid cord-shaped apophyses which enter into the septa and were formerly described as peculiar cæcal canals by Claus (**74**, p. 22) and Korotneff (**50**, p. 272). This is the case in the Discolabidæ (Family XVI.); in these, and perhaps also in other Physonectæ, the

funnel-cavity opens outside by a pore (or stigma) in the median line of the dorsal side, on the base of the pneumatosac; the animal can expel the air through this basal stigma voluntarily (compare **33**, p. 3, and **84**, p. 35).

Nectophores.—The swimming-bells of the numerous Physonectæ exhibit a great variety in number, form, and arrangement. They appear to be wanting in two families, the monogastric Athoridæ (Pl. XXI. fig. 5) and the polygastric Anthophysidæ (Pl. XI.); but in reality they are here replaced by paddling bracts, which are nothing else than modified nectophores. One genus only, *Dicymba* (Pl. XVIII. fig. 1), has two opposite nectophores, similar to *Diphyes* and *Praya* among the Calyconectæ; and the same condition occurs in the young larvæ of Discolabidæ (Pl. XIX. fig. 8), and probably of many other Physonectæ. Usually the number of nectophores is six to twelve or more, in the largest forms thirty to fifty or more. They are arranged in two longitudinal opposite rows in most Apolemidæ, all Agalmidæ (Pls. XIII.–XVII.), some Nectalidæ (*Nectalia*) and Discolabidæ (*Physophora*). Some other genera of the two latter families have four cruciate longitudinal rows (*Sphyrophysa* and *Discolabe*, Pl. XIX.). All Forskalidæ (Pl. VIII.), and *Stephanospira* among the Discolabidæ, possess a strobiliform nectosome, with several spiral rows of nectophores, arranged like the scales of a fir-cone. The Circalidæ (Pl. XXI. fig. 1), finally, are distinguished by the possession of a horizontal corona of nectophores radially arranged, similar to that of the Stephalidæ (Pl. VII. fig. 39). The same arrangement, either in a single horizontal corona, or in several flat, densely apposed spiral rings, is seen in the numerous bracts of the Athoridæ (Pl. XXI. fig. 5) and the Anthophysidæ (Pl. XI. fig. 1). Sometimes the distal end of these paddling bracts still possesses a rudimentary nectosac (*Athoria, Rhodophysa*), and thus proves its nature as a modified nectophore.

Umbrella of the Nectophores.—The fundamental form of the umbrella in all Physonectæ is bilateral and composed of two symmetrically equal halves (antimeres); but it is at the same time quadriradial, marked by the four radial canals. Usually its principal axis is more or less obliquely inclined towards the axial trunk, sometimes almost horizontally; so that the position of the proximal apex is higher than that of the distal ostium. The nectophores of most Physonectæ are depressed and shortened in the dorso-ventral direction, so that the sagittal axis is shorter than the frontal. Usually there arise from the truncate apex two lateral horns or wings, which embrace the trunk. The ventral (or inferior) face of the umbrella has a concave groove, and from its middle line, near the apex, arises the short pedicle which attaches it to the stem. More rarely (in the strobiliform nectosome of the Forskalidæ) the pedicle is longer than the nectophore and arises from the very apex. The jelly-substance of the umbrella is usually rather consistent and firm, sometimes almost cartilaginous.

Nectosac.—The muscular subumbrella of the swimming-bells is of very variable size and form, sometimes little smaller than the umbrella, at other times scarcely half as

large. Usually its form is also bilaterally symmetrical, and often divided into three portions; an odd narrow basal part, and two paired apical wings. The pedicular canal, coming from the cavity of the trunk, divides at the top of the subumbrella into four radial canals. Usually the two sagittal canals (shorter ventral and longer dorsal) have a simply curved course in the median plane of the subumbrella, whilst the two paired lateral canals right and left) are much longer and form several loops. The circular ring-canal, which connects the four radial canals on the ostium of the nectosac above the velum, is usually small. Many Physonectæ bear a red or brown pigment-spot (ocellus) the point where the radial canals open into the ring-canal. But usually only the two lateral canals, or the dorsal also, exhibit this ocellus, whilst the ventral canal has lost it (Pl. XVIII. fig. 9).

Siphosome.—The Physonectæ exhibit very great differences in the form of the siphosome and in its composition from various parts. Accordingly three principal groups (or suborders) may be distinguished in that great order, the Siphostelia, Macrostelia, and Brachystelia. The first group, Siphostelia, are the monogastric Physonectæ (Circalidæ and Athoridæ, Pl. XXI.); the axial trunk is represented by a single central siphon; from the superior or basal part of this (as from the manubrium of a budding Medusa) arise the buds of the various medusomes, which compose the single cormidium. The two other suborders are polygastric, therefore their corm is composed of numerous cormidia. The second group, Macrostelia, has a long tubular trunk of the siphosome, much longer than that of the nectosome, and the siphons of the cormidia are separated by long internodes (Apolemidæ, Agalmidæ, and Forskalidæ, Pls. VIII., XIV., XVIII.). The third group, Brachystelia, on the other hand, possesses a short vesicular trunk of the siphosome, either a flat sac or a spirally convoluted bladder, and the cormidia are densely apposed one to another, with very short internodes (Nectalidæ, Discolabidæ, and Anthophysidæ, Pls. XI., XIII., XIX., XX.).

The long tubular siphosome of the Macrostelia is very extensible and contractile, and exhibits in the most contracted state (Pl. IX. fig. 6) the same appearance which the Brachystelia offer permanently. The long internodes of the former (similar to those of the Calyconectæ) are extremely shortened in the latter. The insertion of the cormidia, however, and of the single parts composing them, is the same in both groups. All parts arise originally by budding from the ventral median line of the trunk, in the same way as the nectophores from the ventral line of the trunk of the nectosome. But when the trunk becomes spirally twisted, then the direction of the spiral turning is usually or always opposite in the two portions of the corm; the spiral of the nectosome is mostly left-handed or lambdoidal (like that of the spiral cnidobands in the tentilla); the spiral of the siphosome, however, is usually right-handed or deltoidal. The cavity of the axial trunk is continuous in both portions. The original situation of the ordinate cormidia, succeeding at equal distances in the straight median ventral line of the trunk, is

permanent in two remarkable genera of the Agalmidæ, *Crystallodes* (Pl. XVII.) and *Stephanomia* (*Amphitrites*, Péron). The horizontally swimming trunk is here so densely covered with thick prismatic bracts, that it becomes rigid and almost every contraction is excluded, no spiral turning possible.

Cormidia.—The arrangement of the polymorphous medusomes in the Physonectæ, their composition and metameric succession along the stem, offer numerous important modifications, hitherto much neglected. The general opinion has been up to this time, that in most Physonectæ the polymorphous persons and their organs are intermingled without definite order, and that only in a few cases, as in *Apolemia* and *Physophora*, they may be disposed according to certain laws, as in the Calyconectæ (8, p. 311, &c.). But in reality the reverse is the case. The great majority of Physonectæ possess ordinate cormidia, and in the minority only irregular cormidia with more or less scattered parts occur. The cormidia are ordinate and separated by free internodes of equal length in the Apolemidæ, and Stephanomidæ (the first subfamily of Agalmidæ); they are also ordinate, but separated by narrow internodes or constrictions of the trunk, in the Nectalidæ, Discolabidæ, and Anthophysidæ. On the other, hand the cormidia are irregularly placed, and the polymorphous parts scattered along the stem, in the Forskalidæ (except *Strobalia*) and the Halistemmidæ (the second subfamily of Agalmidæ).

The cormidia of nearly all Physonectæ are monogastric, with a single siphon and a single tentacle attached to each node of the trunk. A single exception is formed by *Apolemia* and the closely allied *Apolemopsis*; these possess two to four or more siphons in each ordinate cormidium, and the same number of tentacles.

Bracts.—Nearly all Physonectæ possess a great number of hydrophyllia, bracts or covering scales; they are wanting in two families only, the Circalidæ and the Discolabidæ; in the latter they are probably lost by phylogenetic reduction. Usually the bracts cover the entire stem in hundreds or thousands, and arise not only from the nodes of the siphosome, but also from the internodes between them; or even from the pedicles of the siphons (Forskalidæ); but sometimes they arise only from the nodes. Their general function is that of protective organs, or shields, which cover the other parts of the corm; in two families, however, the Athoridæ and Anthophysidæ, where nectophores are wanting, the bracts take on besides a locomotor function and become paddling organs (Pl. XXI. fig. 5; Pl. XI. fig. 1). Sometimes the distal end of the bract in this case encloses a small rudimentary subumbrella, and is thus proved to be developed from a reduced nectophore (Pl. XXI. fig. 6). At other times it is possible that each bract may not be homologous with a complete umbrella, but a separate portion of a cleft (*e.g.*, quadripartite) umbrella. Their jelly-substance is always colourless, hyaline, and transparent, usually rather firm, often cartilaginous. Their form is extremely variable. The bracts in the majority of Physonectæ are rather thin scales, lanceolate or triangular plates, more or less foliaceous or squamiform, with a convex upper (or dorsal) and a

concave lower (or ventral) side; the proximal end being attached to the trunk by a short pedicle, which can be raised and lowered by a muscle. The peripheral margin is usually thin, often with a few teeth. Sometimes the dorsal face is provided with a prominent median crest, or a number of parallel or divergent ribs (three to five or more) which are armed with cnidocysts and prominent at the distal end as free teeth. More rarely the bracts are very thick and compact, either roundish clubs (in the Apolemidæ) or prismatic bodies (in the Crystallodinæ). In these latter they are so thick and densely apposed one to another, that the movable stem loses its contractility and the siphosome becomes rigid. Each bract contains a simple canal, which arises from the trunk, runs along the ventral side of the bracts (usually in the median line), and ends blindly near to its distal end.

Siphons.—The Physonectæ have usually large and well-developed siphons, in which the four usual portions or segments may be distinguished; these exhibit, however, a rather various development in the different groups. The pedicle, or the first portion, is usually a short cylindrical tubule; but it is longer in some Agalmidæ, and very prolonged (similar to a very long lateral branch of the trunk) in the Forskalidæ. The basigaster, the second segment, is usually small, hemispherical or ovate, with a narrow cavity and a thickened exodermal wall, full of cnidocysts; it is often elongated and pyriform, in the Brachystelia (mainly in the Discolabidæ). The true stomach, or third portion of the siphon, is usually the largest part, with a wide and very extensible cavity, the exoderm of which is very muscular, the entoderm glandular. The hepatic glands are usually developed in the form of long parallel hepatic ridges, more rarely in the form of numerous scattered hepatic villi, as in the Athoridæ and Brachystelia (Nectalidæ, Discolabidæ, Anthophysidæ), also in the gigantic *Bathyphysa* among the Forskalidæ. There is, however, no sharp boundary between these two forms of liver; sometimes the hepatic villi are arranged in regular longitudinal series and thus pass over into true liver-ridges ("Leberstreifen"). The number of the latter is usually eight, more rarely four, six, twelve, or sixteen; sometimes four larger perradial ridges alternate regularly with four smaller interradial, and between these are interpolated eight shorter adradial ridges (Pl. IX. fig. 7). The proboscis, or fourth and last portion of the siphon, is usually a cylindrical, very mobile and contractile tube; its distal mouth opening may be expanded in the form of a very large and thin suctorial disc, sometimes circular, at other times polygonal, often octagonal or square. The edge of the mouth is usually armed with peculiar cnidoblasts and palpoblasts. The outside of the siphon is often covered with vibratile epithelium, especially the proboscis.

Tentacles.—Each siphon bears a single tentacle attached to its basal portion, either to the distal part of the pedicle, or to the basigaster itself, often in a constriction between them. The tentacles in all Physonectæ are very long and contractile, cylindrical, tubular filaments, of the same structure as the trunk, with an outer strong layer of exodermal longitudinal muscles, and an inner thin layer of entodermal circular muscles.

They are simple in one family only, the Apolemidæ. In all the other families they bear a series of equidistant lateral branches or tentilla. These are rarely quite simple secondary filaments (*Circalia*). Usually each tentillum is divided into three portions, a basal pedicle, an intermediate cnidoband, and a terminal filament; this latter is either simple or multiple. The greatest variety of structure and form is exhibited by the middle part, the cnidoband (sacculus, "Nesselknopf"), and this presents the chief characters for the distinction of genera. The basal pedicle is always a simple cylindrical tubule, often dilated or vesicular at the distal end.

The cnidoband or cnidonode (cnidosac, sacculus, "Nesselknopf"), the middle and most important portion of the tentillum, is originally nothing more than a dilatation of the middle part of the simple filiform and tubular tentillum, produced by the unilateral development of larger cnidocysts in its wall. Then follows the dislocation of the central canal, which becomes excentrically placed; next a bilateral form, and soon a spiral twisting of the dilated portion. That side, in which the excentric canal runs, is the ventral side of the cnidoband, the opposite, in which the cnidobattery (or the accumulation of larger cnidocysts) is placed, is the dorsal side. Between them is developed the elastic "angleband," a group of two or four parallel elastic ribands. The excentric canal, also more or less coiled, runs in the axis around which the cnidoband is twisted. The spiral is always a left-handed, or lambdoidal. The cnidocysts which compose the cnidobattery are usually of two kinds, very numerous small and paliform, and a smaller number of large ovate or ensiform thread-cells; the latter are arranged usually in two lateral rows on the proximal part of the cnidobattery.

The spiral cnidoband is usually coiled up in three or four left-handed turnings; but sometimes it makes six to eight turnings or even more. It remains naked, without involucrum, in *Athoria* (Pl. XXI. fig. 8), *Halistemma*, the Forskalidæ (Pl. X. fig. 23) and in part of the Anthophysidæ (*Rhodophysa*). In the majority of the Physonectæ there is developed around its proximal end a peculiar involucrum, covering it like a cap or hood; it is a solid annular fold of the exoderm, which arises from the distal end of the pedicle and grows distally. Claus maintains that this envelope "evidently corresponds in morphological relation to the umbrella of a Medusa" (**74**, p. 2); but their likeness is merely external. The involucrum is nothing more than a simple protecting mantle for the naked cnidoband. At first it envelops the proximal base only (*Stephanomia*, *Cupulita*, *Anthemodes*, Pl. XV. fig. 11, &c.), but afterwards it grows around the entire cnidoband and envelops it distally as an external capsule. The most complicated structure is exhibited by the involucrum in the Discolabidæ; where it often bears a pair of red lateral ocelli (Pl. XX. fig. 14); the convex dorsal side is here so strongly developed, prolonged and much twisted, that the cnidoband is recurved and its distal end placed near the proximal base on the contracted ventral side; the terminal filament becomes reduced in this case and finally disappears.

The simple terminal filament is permanent in the majority of the Physonectæ (in all Forskalidæ, a great part of the Agalmidæ, *Stephanomia*, *Anthemodes*, Pl. XV. fig. 11, *Cupulita*, &c.), some Anthophysidæ, &c. But in another great part of the genera it becomes trifid and developed in the form of three terminal appendages, an odd median vesicle (or terminal ampulla) and two paired lateral filaments or horns (*Crystallodes*, Pl. XVII. figs. 4, 5, *Agalma*, Pl. XVIII. fig. 14, *Agalmopsis*, &c.). To these three appendages is added in *Athorybia* a peculiar conical solid appendage, a dorsal spur (Pl. XII. figs. 12, 13, *tf*), and in the closely allied *Anthophysa* a pair of two lateral palmate appendages on the dorsal side. The remarkable Agalmid *Lychnagalma* is distinguished by a large hydrostatic terminal ampulla, and a corona of eight radial filaments surrounding it (Pl. XVI. figs. 1, 9).

Palpons.—Hydrocysts or tasters are generally present in all Physonectæ, and usually in far greater number than the siphons, so that each cormidium possesses a group of several palpons (Pl. XII. figs. 7–9, *q*; Pl. XVIII. fig. 2, *q*, &c.). The true palpons or tasters are, however, often confounded with other organs, especially with the cystons and even with the tentacles (Claus, **34**, **35**, &c.). The true palpons are mouthless, cylindrical, pyriform or spindle-shaped tubes, which morphologically correspond to the manubrium of a Medusa, but not to the tentacle. They differ from the siphons as well as from the cystons, in the absence of a distal opening; also from the former in the simpler structure of their thin very contractile wall, and especially in the absence of hepatic glands, and of a basigaster. Sometimes, however, two annular constrictions are more or less distinct, so that a short pedicle, a middle main part and a distal appendage or terminal ampulla may be distinguished. The latter often exhibits various structures, an accumulation of terminal cnidocysts, of pigment, of palpoblasts, &c. The main function of this distal part seems to be sensory, mainly feeling; sometimes an ocellus is developed on its dorsal side, provided in some species with a small lens (Pl. XI. fig. 4, *qo*); at other times the spherical distal end is separated by a constriction from the main part and contains a group of crystals or concretions, rotated by vibratile epithelium, thus resembling an otocyst. The largest palpons are developed in the Discolabidæ (Pl. XIX. fig. 1), where they replace the missing bracts; they form at the proximal end of the siphosome a corona of very large and thick-walled protecting tubes, which are at the same time vigorous capturing arms; each ordinate cormidium possesses either two palpons (*Physophora*) or a single large one (*Discolabe*). Another part of the palpons has a direct relation to the gonophores, and the gonostyles may be originally always sexual palpons. These latter have often a peculiar structure and may be distinguished as gonopalpons. Those corms of the Physonectæ which have ordinate cormidia usually possess a constant number of palpons attached above the base of the siphon; in those corms, however, in which the cormidia are dissolved, usually very numerous palpons are scattered along the whole trunk of the siphosome.

Cystons.—Numerous Physonectæ, mainly the Macrostelia (Apolemidæ, Agalmidæ, and Forskalidæ), possess cystons or anal vesicles, excretory polypites which occur in no other order of Siphonophoræ. They have hitherto been confounded with the similar palpons, although some authors have observed the distal opening, by which fluid and crystalline excretions are ejected. The cystons differ from the similar but smaller palpons essentially in the possession of the distal opening, which may be closed by a muscular sphincter, and with respect to its function called an anus (Pl. XV. figs. 8, 9, *yo*). They seem to differ further in the peculiar structure of the wall, which is often intensely coloured (Pl. XVIII. fig. 2, *y*) and glandular, at least in the distal part. The characteristic hepatic glands of the siphons, however, are wanting. The cystons are therefore excretory polypites, which in morphological relations are intermediate between the digesting siphons and the feeling palpons. I have never observed more than a single cyston in each monogastric cormidium. In the polygastric cormidia of the Apolemidæ the number of cystons seems to correspond to that of the siphons.

Palpacles.—Usually in the Physonectæ each single palpon, as well as cyston, is provided at its base with a long palpacle, or a simple "accessory tentacle." It is a very slender, never branched, cylindrical tubule, the thin wall of which contains small cnidoblasts and palpoblasts. It is in perpetual motion, and its function is mainly sensory. Perhaps these feeling filaments ("Tastfäden") are generally distributed among the Physonectæ; they are not observed in various genera, but it may be possible that here they have been either overlooked or lost accidentally.

Gonodendra.—Nearly all the Physonectæ have monœcious corms, male and female gonodendra being developed from the same trunk. There are two exceptions only where the corms are dicœcious:—*Athoralia* among the monogastric, and *Apolemia* among the polygastric Physonects; in these two genera each corm bears either male or female gonodendra.

The ordinate cormidia are usually monoclinic, each provided with two gonodendra, a male and a female, which arise separately from the node of the trunk (Pl. XVIII. fig. 2; Pl. XX. figs. 9–16). Usually here the female is placed more proximally (near the palpon) and the male more distally (near the siphon). These gonodendra may be called distylic, since their stems or gonostyles are two independent branched palpons. There occur, however, sometimes monostylic gonodendra, where the basal part of the single branched gonostyle bears female, and the distal part male gonophores. This is the case in *Forskalia* (Pl. X. fig. 21; compare Kölliker, 4, Tab. ii. fig. 1).

The irregular cormidia are sometimes monoclinic, at other times diclinic; in the former male and female gonodendra occur scattered over the same internode; in the latter arising separately from different internodes. In many Physonectæ with irregular cormidia (mainly Halistemmidæ) very numerous gonodendra of both sexes are scattered irregularly along the whole trunk.

Gonostyles.—The stems of the gonodendra, which bear the clustered gonophores, and which we call gonostyles, are sometimes themselves simple palpons, at other times branches of sexual palpons, or in a peculiar manner combined with sterile palpons. The ramification is in most Physonectæ not very rich (mainly in the males), and not to be compared with that of the Cystonectæ. There are, however, exceptions, as in the female gonodendra of some Discolabidæ (Pl. XX. figs. 11–16). The male gonostyles of the latter exhibit a peculiar appearance, since their distal part, after the detachment of the ripe androphores, is covered with tubercles (as the remaining pedicles of the latter), whilst the proximal part produces vicarious gonophores.

Gonophores.—The medusiform gonophores of the Physonectæ are in general of small size, especially the females. Their umbrella is sometimes well developed, with four equidistant radial canals and a marginal ring-canal, whilst at other times it is more or less reduced, and sometimes rudimentary. The manubrium is larger in the androphores, where it is usually club-shaped or cylindrical, with a central spadix; often coloured white, yellow, or red; it is often very prominent from the narrow mouth of the reduced umbrella (Pl. XII. fig. 17; Pl. XVIII. fig. 17, &c.). The manubrium of the gynophores is much smaller, ovate or subspherical, and develops constantly a single large ovum only. This is often surrounded by an irregular network of peculiar anastomosing canals (Pl. XV. fig. 15; Pl. XVIII. fig. 16). These "spadicine canals" arise by a peculiar process: the original central spadix in the axis of the young ovarium becomes excentric by the unilateral development of a single large ovum; it grows around the latter in the form of a hemispherical cup, and envelops it finally like a capsule; by the partial irregular concrescence of its two walls arises the reticulum of canals, which is called "netzförmiges Canal-System" by German authors.[1]

Ontogeny.—The development of the fertilised egg is hitherto known in the case of only very few Physonectæ. The first observations on it were made by myself in the Canary Island Lanzerote, in December 1866, and January and February 1867. I was able to observe there the embryonic development and the metamorphosis of *Physophora magnifica*, *Crystallodes rigida*, and *Athorybia ocellata* (**84**, Tafs. i.–xiv.). Further observations were published in 1874 by Metschnikoff, who illustrated the ontogeny of *Halistemma rubrum*, *Cupulita picta*, and *Agalmopsis sarsii* (**85**, Tafs. viii.–xii.). The embryology of *Agalma elegans* was afterwards described by Fewkes (**89**, pls. i.–iv.). Judging from these few observations, it seems that the Physonectæ are subject to a rather complicated metamorphosis and produce medusiform larvæ, the morphological value of which is probably very great for their phylogeny. Usually these monogastric larvæ (*Physonula*) develop the pneumatophore from their exumbrella very early, and around it a corona of provisional bracts. (Compare Family XI., Athoridæ, p. 200, and Pl. XXI. figs. 5–13.)

[1] Compare Weismann, Die Entstehung der Sexual-Zellen bei den Hydromedusen, 1883, p. 206.

Synopsis of the Eight Families of Physonectæ.

PHYSONECTÆ MONOGASTRICÆ, with a single siphon and a single tentacle (*Siphostelia*).			Nectosome with a corona of nectophores, without bracts,	10. Circalidæ.
			Nectosome with a corona of bracts, without nectophores,	11. Athoridæ.
PHYSONECTÆ POLYGASTRICÆ, with numerous siphons, each of which is provided with a tentacle.	Siphosome with a long tubular stem, longer than the axis of the nectosome (*Macrostelia*).	Nectosome biserial, with two opposite rows of nectophores.	Pneumatophore without radial pouches. Tentacles simple,	12. Apolemidæ.
			Pneumatophore with radial pouches. Tentacles branched,	13. Agalmidæ.
		Nectosome multiserial, strobiliform, with several spiral rows of nectophores,		14. Forskalidæ.
	Siphosome with a short vesicular stem, shorter than the axis of the nectosome (*Brachystelia*).	Nectosome with two, four, or more rows of nectophores.	Siphosome with a corona of bracts,	15. Nectalidæ.
			Siphosome without bracts,	16. Discolabidæ.
		Nectosome without nectophores, instead of these a corona of bracts,		17. Anthophysidæ.

Family X. CIRCALIDÆ, Haeckel, 1888.

Circalidæ, Hkl., System der Siphonophoren, p. 38.

Definition.—Physonectæ monogastricæ without bracts, with a corona of nectophores which surrounds the pneumatophore, and a corona of palpons which surrounds the base of the single siphon and the single tentacle. Pneumatophore with radial pouches.

The family Circalidæ is founded by me for the new genus *Circalia*, and comprises those monogastric Physonectæ which possess an upper corona of nectophores around the apical pneumatophore, and a lower corona of palpons around the basal siphon. They are similar to the polygastric Discolabidæ, and may be compared to a *Stephanospira* which has developed a single siphon only and a single spiral row of nectophores.

The single specimen of *Circalia* which I have been able to examine living was observed by me in September 1869 on the west coast of Norway, off the mouth of Sogne Fjord; it is figured in Pl. XXI. figs. 1–4. But perhaps there belongs to the same genus (or forms a new closely allied genus) another, larger, monogastric Physonect, which was captured in August 1826 by Captain Dumont d'Urville in the Atlantic Ocean (lat. 30° S., long. 15° E.). It is described and figured by Quoy and Gaimard under the name *Physophora alba*.[1] L. Agassiz afterwards established for it the genus *Haplorhiza* (a name previously employed for a Rhizostomid) (**36**, p. 368). According to the description

[1] Voyage de "l'Astrolabe" (Zoophytes), p. 53, pl. i. figs. 1–9.

of the French observers, the apical pneumatophore was surrounded by a corona of five nectophores, and the single large basal siphon by a corona of numerous palpons; two tentacles are figured, but probably these were only parts of a loop of a single one. The tentilla, however, arranged in a single long series along the tentacle, were not simple lateral branches as in our *Circalia stephanoma*, but provided with an ovate cnidosac at the distal end. It is possible, therefore, that this *Circalia haplorhiza* represents another genus of Circalidæ; it may be called provisionally *Circonalia*.

Another monogastric Physonect, which is very similar to *Circalia*, and inhabits the western part of the Gulf Stream (near the Tortugas Reefs, Florida), has recently been described by Fewkes under the name *Agalma papillosum*. Its nectophores are papillate, and the tentilla, which form a long series on the single tentacle, are tricornuate with a median terminal ampulla and two lateral horns at the distal end of the spiral cnidoband (as in *Agalma*, *Agalmopsis*, &c.). But since no gonophores were observed on this remarkable form, it is perhaps only the larva of another Physonect.

The single cormidium, which represents the mature corm of *Circalia*, is of great interest on account of its typical simplicity and its morphological relations to other Siphonanths, especially to the Discolabidæ (*Physophora*, *Stephanospira*) on one hand, and to the Rhodalidæ (*Stephalia*, *Rhodalia*) on the other hand. The entire cormidium may be compared with a Medusa, which has preserved the original simple manubrium (the central siphon), but whose umbrella has been transformed into a pneumatophore, and produced by budding (from the base of the manubrium) a corona of radial medusomes (eight in *Circalia stephanoma*), each medusome being composed of a proximal nectophore and a distal palpon (or a pair of palpons), and beyond this a gonodendron.

It is perhaps a fact of great morphological value, that the octoradial type of Medusa in *Circalia* is expressed not only in the structure of the pneumatophore (with eight radial pouches of the cavity, and eight pigment-rays at the apex), and of the single central siphon (with eight liver-ridges and eight mouth-lobes), but also in the composition of the nectosome (with eight radial nectophores) and of the siphosome (with sixteen palpons and eight gonodendra); these latter numbers, however, may be accidental.

Comparing the entire corm of *Circalia* with a single Medusa, which has produced a cormidium by budding from the base of the manubrium, we get a further support for our medusome theory (p. 3). The transformed umbrella of the original Medusa person is the apical pneumatophore; its manubrium is the prolonged central siphon. The distal and lower part of the siphon only has preserved the function of a feeding and digesting stomach, whilst the proximal and upper part represents the axial trunk of the corm, from which the buds arise. These buds may have been originally simple Medusæ, but afterwards transformed into loose medusomes; the umbrella of the secondary Medusa has been developed into a nectophore, the dislocated manubrium into a palpon,

and its single tentacle into a palpacle. Beyond these sterile medusomes have been developed the fertile ones, in the form of gonostyles, which have produced by budding the gonodendra composed of numerous Medusoid gonophores.

Genus 36. *Circalia*,[1] Haeckel, 1888.

Circalia, Hkl., System der Siphonophoren, p. 38.

Definition.—Circalidæ with a single corona of nectophores radially arranged around the pneumatophore, and with a series of simple filiform tentilla on the single tentacle.

The genus *Circalia* (Pl. XXI. figs. 1–4), as the single known genus of Circalidæ, possesses the characters of the family described above. As a peculiar character of the genus may be pointed out the remarkable composition of the corona of (eight) radial nectophores, similar to that of *Stephalia* (Pl. VII. figs. 39, 48). Another character of generic value may be the simple tubular shape of the tentilla, or the filiform lateral branches of the single tentacle (similar to *Nectophysa wyvillei*, Pl. XXIII. fig. 5). It differs in this from the similar *Circonalia haplorhiza* (=*Physophora alba*, Quoy and Gaimard, 2). Compare above, p. 197.

Circalia stephanoma, n. sp. (Pl. XXI. figs. 1–4).

Habitat.—North Atlantic, west coast of Norway, near the Sogne Fjord; September 1869 (Haeckel).

Nectosome.—The swimming apparatus has a diameter of about 5 mm., and is composed of a large apical pneumatophore and a corona of eight nectophores radially arranged around it. These are attached by short ventral pedicles to a central axial trunk, the uppermost dilated part of which is the pneumatophore, whilst the lower part of the trunk passes over directly into the base of the siphon. From the dorsal side of the latter arises the single tentacle, whilst in the median line of the opposite ventral side (between the two ventral nectophores) a small group of young buds is visible.

Pneumatophore.—The float at the apex of the trunk is pyriform or subspherical, of about the same size as the nectophores (2 or 3 mm. in diameter). Its apex bears a ventral depression or umbilicus (perhaps the closed opening ?) and around this a red-brown pigment-star, composed of eight equidistant triangular rays. The basal half exhibits eight longitudinal grooves, the insertions of the radial septa which divide the cavity of the pneumatophore into eight radial pouches (fig. 4, *pq*, in horizontal transverse section).

Nectophores (figs. 1, 2, *n*).—The eight swimming-bells which compose the octoradial corona around the central pneumatophore are of rather regular campanulate form.

[1] *Circalia*=Marine corona, κίρκος, ἅλιος.

Their principal axis is longer than the transverse axis, and is directed obliquely from above downwards and outwards. The dorsal or superior face is convex in the proximal, concave in the distal part. The opposed ventral or inferior face is more concave, with a ridge in the middle line; from the upper or apical part of this ridge arises the short pedicle which attaches the nectophore to the axial trunk. Their jelly-umbrella is rather thin, but firm. The nectosac is large; its four equidistant radial canals are of nearly equal length and run in a simple curve (without loops) from the top of the subumbrella (where the pedicular canal enters) towards the basal ostium; they are here united by a circular ring-canal, above the small velum.

Siphosome.—The basal part of the monogastric corm, below the nectosome, is composed of a single, very large central siphon, and a corona of numerous palpons which surround its proximal base; each palpon bears a simple palpacle, whilst the siphon bears at its dorsal side a single very long tentacle, beset with a row of numerous tentilla. The basal part of the siphon, immediately below the palpons, is surrounded by a corona of gonophores. The diameter of the siphosome in the expanded state is about 10 mm.

Siphon (*s*).—The large central polypite, which represents the axial trunk of the monogastric corm, is divided into four segments. The first and uppermost segment, comparable to the pedicle of the siphons of the polygastric Siphonanthæ, is a cylindrical vertical tube, to which are attached three coronas; the upper corona composed of nectophores, the middle of palpons, and the lower of gonophores. Below this follows the second segment, corresponding to the basigaster, a small ovate dilatation with a thickened wall full of cnidocysts. The third segment is the large spindle-shaped stomach, the wall of which exhibits eight equidistant red-brown villous hepatic ridges (*sh*). The fourth and last segment is the distal proboscis (*sr*), a very contractile cylindrical tube with eight strong longitudinal muscle-bands. Its terminal mouth opening exhibits eight rounded radial lobes (*ss*).

Tentacle (*t*).—The single large tentacle, which arises from the base of the siphon on its dorsal side, is a very long cylindrical tube, furnished with a single series of very numerous tentilla (*ts*); these are simple thin lateral branches of the tentacle, densely covered with small ovate cnidocysts. The structure of the tentacle is similar to that of *Nectophysa wyvillei* (Pl. XXIII. figs. 5, 6).

Palpons (*q*) *and Palpacles* (*r*).—The corona of palpons which is expanded around the base of the siphosome, immediately below the nectosome, is very similar to that of the Discolabidæ. It is composed (in the single specimen observed) of sixteen to twenty—or perhaps more—cylindrical tubular palpons, tapering towards the two ends; the proximal end is rounded and attached by a short and thin pedicle to the axial trunk; the distal end is closed, pointed, and armed with a group of cnidocysts. From the dorsal side of the basal pedicle arises a long and very movable palpacle, a thin cylindrical tubule, the wall of which contains small cnidocysts.

Gonodendra.—The corm is monœcious and monoclinic, and bears numerous gonophores of both sexes, densely crowded beyond the corona of palpons, and forming an inner corona around the base of the siphon. At the first glance I supposed that this corona was composed of two large gonodendra only, a male and a female. A closer examination, however, of the well-preserved spirit specimen, informed me that it was composed of eight small gonodendra, four males (fig. 3, *h*) and four females (fig. 3, *f*) alternating. The umbrella is well developed in both sexes, with four radial canals and a ring-canal. Each gynophore contains a single large ovum, each androphore a club-shaped spermarium with a central spadix.

Family XI. Athoridæ, Haeckel, 1888.

Athoridæ, Hkl., System der Siphonophoren, p. 38.

Definition.—Physonectæ monogastricæ without nectophores, with a corona of bracts which surrounds the pneumatophore, and a corona of palpons which surrounds the base of the single siphon and the single tentacle. Pneumatophore without radial pouches.

The family Athoridæ comprises some small, hitherto undescribed Physonectæ, which are in general similar to *Athorybia* or *Anthophysa*, but differ essentially from them in the possession of only a single siphon. They agree with these Anthophysidæ (Family XVII.) in the absence of nectophores, which are replaced by a corona of bracts. On the other hand, they are similar to those well known Athorula-larvæ, or "Athorybia-like larvæ," which are developed from the fertilised egg of certain Physonectæ, especially Agalmidæ. Compare Vogt (**6**, pl. x. figs. 32–37), Gegenbaur (**7**, Taf. xvii. fig. 11), Claus (**35**, p. 557, Taf. xlviii.), Haeckel (**84**, Tafs. vii., viii., ix., fig. 60), Metschnikoff (**85**, Tafs. ix., xi.), Fewkes (**89**, pl. iv.).

The resemblance of the monogastric Athoridæ to these larvæ of polygastric Agalmidæ, and the morphological likeness of their structure, make it probable that the former are either remnants of the ancestral forms of the latter, or that they are larval forms which under certain conditions sometimes attain sexual maturity (Pædogenesis). A further accurate examination of these interesting small Physonects, and a complete knowledge of their anatomy as well as ontogeny are required to recognise their relations to the other families of this order.

Two different forms of Athoridæ were observed by me in 1881 during my residence in Ceylon. The first and larger, *Athoralia coronula*, was very similar to a small young *Athorybia* (Pls. XI., XII.); it will be described on another occasion. The second and smaller form is described in the sequel as *Athoria larvalis* (Pl. XXI. figs. 5–8); it differs from the former in the possession of a small rudimentary nectosac at the distal

end of the bracts, similar to that which is found in some Athorula larvæ of Agalmidæ (Pl. XXI. figs. 7, 10, 12). Another similar form, but with more numerous and slender bracts, was found in a preparation in the Challenger collection (*Athoria bractealis*). It was insufficiently preserved. Possibly these small and delicate Physonects have already been seen by former observers, but regarded as mere larvæ.

The entire corm of these monogastric Athoridæ represents a single cormidium, and may be regarded as a medusome, the umbrella of which is the pneumatophore, and the manubrium the central siphon. From the proximal base of the latter is produced by budding a corona of secondary medusomes; each of these is again composed of a modified umbrella (the bract) and a manubrium (the palpon); the palpacle, which is attached to the base of each palpon, is the persistent tentacle. The gonophores, which are developed beyond the palpons, represent a second corona of medusomes, which become sexually mature. The small nectosac which occupies the distal end of the bracts in *Athoria* is of special interest, since it demonstrates that the bracts are modified umbrellæ.

Synopsis of the Genera of Athoridæ.

Bracts with a rudimentary nectosac on the distal end. Corms monœcious. Tentilla without involucrum, ... 37. *Athoria.*

Bracts without rudimentary nectosac. Corms dicecious. Tentilla with an involucrate cnidoband, ... 38. *Athoralia.*

Genus 37. *Athoria*,[1] Haeckel, 1888.

Athoria, Hkl., System der Siphonophoren, p. 39.

Definition.—Athoridæ with a rudimentary nectosac at the distal end of the bracts. Tentilla with a naked spiral cnidoband, without involucrum. Corms monœcious.

The genus *Athoria* is remarkable for the possession of a rudimentary subumbrella, a small campanulate nectosac at the distal end of the bracts; its mouth is armed with four groups of cnidocysts which may be regarded as small rudiments of tentacles. They agree in this character with the genus *Rhodophysa* among the Anthophysidæ (Genus 58) and with the Athorula larvæ mentioned above (p. 200). The tentilla are similar to those of *Halistemma* and *Forskalia*, with a naked spiral cnidoband. *Athoria larvalis* (Pl. XXI. figs. 5–8) was observed living by me in Ceylon. A similar species, but larger, with more numerous and slender bracts, was found in a mounting of the Challenger collection (from Station 288, South Pacific). It was not well enough preserved to be described and figured.

[1] *Athoria*, name of an Oceanid, Ἀθώρια.

Athoria larvalis, n. sp. (Pl. XXI. figs. 5–8).

Habitat.—Indian Ocean; Belligemma, Ceylon, December 1881 (Haeckel).

Nectosome.—The swimming apparatus is composed of an apical pneumatophore and a corona of fifteen to twenty large bracts; these are attached by the pointed end of a pyramidal pedicle to the axial trunk, immediately below the base of the float. They are raised and lowered by special muscles in the same manner as in the similar Anthophysidæ. The thick bracts are therefore not only protective but also paddling organs, as in *Athorybia*. The diameter of the entire nectosome is 5 to 6 mm.

Pneumatophore (figs. 5, 6, *p*).—The apical float is of medium size, pyriform, with rounded top and dilated basal part. The latter is divided by a horizontal annular constriction (or pneumatic pylorus) into an upper and a lower cavity; the greenish epithelium of the latter is the pneumadenia. A chitinous pneumatocyst (fig. 6, *pf*) was recognisable in the upper part. The pericystal cavity of the pneumatophore (*pc*) is simple, without radial septa; similar to that of the Apolemidæ.

Bracts (figs. 5, 6, *b*).—The large hydrophyllia are five-sided, prismatic, with five prominent convex edges, about three times as long as thick. An odd superior or dorsal edge, and the two parallel dorso-lateral edges are elegantly denticulate, whilst the two inferior or ventro-lateral edges are smooth. The ventral or axial face between the last is concave. The proximal fourth of the bract is a five-sided irregular pyramid and its apex prolonged into the short pedicle, which attaches the hydrophyllium to the trunk. The distal third is obliquely truncated and contains a small hemispherical or campanulate cavity (fig. 6, *bs*). This is the rudimentary subumbrella, the muscular nectosac of which is preserved. The simple bracteal canal (*bc*) which enters by the pedicle, runs along the middle line of the concave ventral face and touches the top of the subumbrella; four very small radial canals (*cr*) seem to arise from it, run along the nectosac towards its small distal ostium, and are there connected by a small ring-canal. The four equidistant points, where they open into the ring, are armed with a small cnidonode (*k*), which is composed of four cnidocysts (rudiments of lost tentacles ?).

Siphosome.—The inferior part of the corm, beyond the superior corona of bracts, is composed of a large central siphon and a corona of palpons which surrounds its proximal base. From this arises a long tentacle, beset with a series of tentilla. Each palpon bears at its base a simple palpacle. A pair of gonostyles is attached on each side of the trunk of the siphonal pedicle, between the palpons and the basigaster. The male gonophore lies on the left and the female on the right side of the siphon, whilst the insertion of the tentacle occupies the middle of the dorsal side of its base, and a small group of buds the middle line of its ventral side. The frontal section in fig. 6, which exhibits these topographic relations, is semi-diagrammatic.

Siphon (figs. 5, 6, *s*).—The large central polypite which represents the axial trunk of the monogastric corm is composed of four distinct segments. The first and uppermost segment, which corresponds to the pedicle of the siphons in the polygastric Siphonanthæ, is a vertical spindle-shaped tube which passes over above into the pneumatophore, below into the basigaster. From this basal segment (*at*) arise three coronas of lateral appendages, the upper corona of bracts (*b*), the middle corona of palpons (*q*), and the lower corona of gonophores (*f*, *h*). The second portion of the siphon is a pyriform basigaster (*sb*), the thick exoderm wall of which is filled with cnidocysts. The third and largest segment (*sm*) is the wide cylindrical or spindle-shaped stomach; its thickened entoderm bears numerous conical glandular villi, which usually contain one or two glossy, strongly refracting globules (vacuoles ?). The fourth and last segment is the distal proboscis (*sr*), a very contractile and muscular cylindrical tube which opens through the distal mouth; this may be expanded in the form of a broad lobulate suctorial disc (*ss*).

Tentacle (figs. 5, 6, *t*).—The single capturing filament, which arises from the base of the siphon on its dorsal side, is a long cylindrical tube and bears a series of very numerous tentilla. These are composed of three parts, a slender proximal pedicle (fig. 8, *ts*), a broader cnidoband in the middle (*tk*), and a simple thin terminal filament (*tf*). The cnidoband is naked, without involucrum (as in *Rhodophysa*, *Forskalia*, and *Halistemma*); it is a simple spiral, like a cork-screw, with four or five turns.

Palpons (fig. 6, *q*) *and Palpacles* (*r*).—The palpons are attached to the axial trunk immediately below the bracts and seem to correspond in number to the latter (fifteen to twenty). They may perhaps be regarded as the dislocated manubria of the medusomes, the transformed umbrellas of which are the bracts. Each palpon is a very retractile cylindrical tube, tapering towards the two ends. The open proximal end is attached by a short pedicle to the trunk and communicates with its cavity; the closed distal end is pointed and armed with a bunch of cnidocysts, and coloured with bright-red pigment-spots. From the pedicle arises on its upper or dorsal side the palpacle, a long, thin, simple filament, beset with small cnidocysts (fig. 6, *r*).

Gonodendra.—Below the corona of palpons, between it and the basigaster (*sb*), is attached to the trunk an annular group of small buds. These seem to develop into gonophores; but only two small gonodendra were developed in the specimen figured, a male and a female. These were so disposed symmetrically, that the female gonophore (fig. 6, *f*) occupied the right side, and the male gonophore (*h*) the left side of the basigaster. The clustered gonophores were small and very numerous, with a well-developed umbrella, four radial canals, and a ring-canal. The female manubrium is subspherical and contains a single large ovum; the male manubrium is club-shaped and the central spadix surrounded by ripe sperm.

Genus 38. *Athoralia*,[1] Haeckel, 1888.

Athoralia, Hkl., System der Siphonophoren, p. 39.

Definition.—Athoridæ without a nectosac at the distal end of the bracts. Tentilla with an involucre around the spiral cnidoband. Corms dicœcious.

The genus *Athoralia* differs from the preceding similar *Athoria* in three characters. The rudimentary nectosac, which occupies the distal end of the bracts in the latter, is wanting in the former; the corms are dicœcious; and the cnidoband of the tentilla is not naked, but enveloped by an involucrum. *Athoralia*, therefore, has a relation to *Athoria* similar to that which *Athorybia* exhibits to *Rhodophysa*. A single species only, *Athoralia coronula*, was observed by me, in December 1881, during my residence in Ceylon. It was very similar to a small young *Athorybia*, but possessed a single siphon only, with a single tentacle. Three specimens of it were captured, one male and two females. The former possessed a single small gonodendron, composed of about a dozen club-shaped spermaria, besides a number of young buds. Each of the two females had also only a single gonodendron, composed of numerous clustered, very small gynophores, each containing a single ovum. *Athoralia coronula* is therefore one of the rare dicœcious Physonectæ, like *Apolemia*.

Family XII. Apolemidæ, Huxley, 1859.

Apolemidæ, Huxley, Oceanic Hydrozoa, pp. 70, 127.

Definition.—Physonectæ polygastricæ, with a long tubular stem of the siphosome, bearing numerous siphons, palpons, and bracts, each siphon provided with a simple unbranched tentacle. Nectosome biserial, with two opposite nectophores or two alternate series of opposite nectophores. Pneumatophore without radial pouches.

The family Apolemidæ, founded by Huxley upon the single genus *Apolemia*, comprises those Physonectæ which possess a biserial nectosome and a long tubular stem of the siphosome, similar to the Agalmidæ. They differ, however, from these latter in two important points. The pneumatophore is a simple glandular invagination of the top of the trunk, whilst in the Agalmidæ the pericystic cavity is divided by vertical septa into radial pouches. Further, the tentacles in the former are simple, not branched filaments, whilst in the latter they bear a series of lateral branches or tentilla, each provided with a cnidobattery.

The first Siphonophore belonging to this family was observed in the North Atlantic by Lesueur, who in 1813 executed a large and excellent picture of it, drawn and engraved by himself from life. He called it *Stephanomia uviformis* (not *uvaria*). Eschscholtz observed the same animal in the North Atlantic, and recognising it in the

[1] *Athoralia*, derived from *Athoria*.

unpublished plate of Lesueur, founded upon it a new genus, *Apolemia uvaria* (1829, **1**, p. 143). Blainville copied in 1834 a part of Lesueur's splendid figures in his Actinologie (**24**, pl. iii. fig. 1), and Lesson copied the description of it and named it "*Apolemia Lesueuria*" (**3**, p. 518). I myself obtained in 1878 at Paris, owing to the kindness of Professor Perrier, a copy of Lesueur's beautiful plate, and on comparing it with the Mediterranean *Apolemia uvaria*, was convinced that these two forms are not identical, as preceding observers had supposed, but belong to different species or even genera.

The Mediterranean *Apolemia uvaria*, the largest Physonect of this sea, was described in the years 1853 to 1863 by Kölliker (**4**), Vogt (**6**), Gegenbaur (**7**), Leuckart (**8**), and Claus (**35**). The descriptions of these authors together give a satisfactory idea of this interesting type of the family. It differs from the *Apolemia lesueuria* in the dicœcious corm and the naked internodes of the siphosome, which in the latter are densely covered with innumerable bracts. Since the corms, too, in this latter are moncœcious, I separate it as *Apolemopsis lesueuria*.

Closely related to this latter seems to be an Apolemid from the Tropical Pacific, which Mertens observed near the Caroline Islands, and Brandt described in 1835 under the name *Apolemopsis dubia* (**25**, p. 36). Comparing the accurate figure of it, which Mertens had drawn from life, with the plate of Lesueur, I think these two forms belong to the same genus, but are distinct species.

During my voyage through the Indian Ocean, from Aden to Bombay, in 1881, I captured a single but complete specimen of the interesting new Physonect, which is figured in Pl. XVIII. figs. 1–7, of this Report, under the name *Dicymba diphyopsis*. The composition of the corm and the form of the single organs are almost as in the well-known Mediterranean *Apolemia uvaria;* but there are two important differences; the nectosome is composed of two opposite nectophores only (as in *Praya* and *Diphyes*), and the cormidia are monogastric, with a single siphon and tentacle (as in the Diphyidæ and Agalmidæ). This Indian Physonect may therefore be regarded as the type of a new subfamily, or even family—Dicymbidæ.

Nectosome.—The swimming apparatus of the Apolemidæ is similar to that of the Agalmidæ, but differs from it in two characteristic peculiarities. The pneumatophore is a simple invagination of the exoderm, without radial pouches; and the nectophores beyond it are provided with tentacles wanting in the Agalmidæ. The number of nectophores is different in the two subfamilies; *Dicymba*, the single known type of the subfamily Dicymbidæ, possesses only two large opposite nectophores, similar to *Praya* and *Diphyes*, and approaches in this as well as in other respects to the Diphyidæ. The subfamily Apolemopsidæ, represented by *Apolemia* and *Apolemopsis*, on the other hand, has two obliquely opposite series of alternating nectophores (four to six pairs or more), similar to the Polyphyidæ and Agalmidæ. The long and thin contractile filaments which arise from the trunk of the nectosome between the single nectophores are

generally described as "tasters." It may, however, be possible, that they are originally not palpons, but palpacles. In this case their morphological value would be different, as is now assumed. They would be the dislocated tentacles, and not the manubrium of the metamorphosed medusome, the umbrella of which is the nectophore. A proof of this explanation seems to be given by the fact, that in *Apolemopsis* (according to the accurate figure of Lesueur) a bunch of four tasting filaments arises from the base of each nectophore. Kölliker (4, p. 19) and Leuckart (8, p. 317) state, that in *Apolemia* also a bunch of three or four tasters belongs to each single nectophore.

Pneumatophore.—The float filled with air is relatively small in the Apolemidæ, compared with the large nectophores. It has a very simple structure, as in the oldest and lowest forms of Physonectæ. The ovate pneumatosaccus (which sometimes contains no pneumatocyst ?) is a simple invagination of the apex of the tubular trunk. The inflated pyriform uppermost part of the latter, or the pneumatocodon, which loosely surrounds the pneumatosac, is not connected with it by vertical radial septa (as is constantly the case in the Agalmidæ and Forskalidæ). There is wanting, therefore, in the Apolemidæ the corona of radial pouches which is characteristic of the pneumatophore in the two latter families. The spheroidal basal or lowermost part of the pneumatosac —the pneumatic infundibulum, or the gas-secreting gland, pneumadenia—is separated from its ovate larger upper part by an incomplete annular constriction, the pneumatopyle (pylorus infundibuli). (Compare 50, p. 272, Taf. xix. fig. 93.)

Nectophores.—The large and vigorous nectocalyces of the Apolemidæ have a somewhat different shape in the two subfamilies. The two opposite nectophores of *Dicymba* (Pl. XVIII. fig. 1) resemble those of *Praya* (Pl. XXXI. figs. 1–7). They are ovate, with a rounded and edgeless exumbrella, and bear at the ventral or axial side a large longitudinal furrow, bounded by two parallel wings; between these wings there arises in the upper part the lamellar triangular pedicle, which attaches the nectophores to the top of the stem, beyond the pneumatophore. The two ventral grooves of the two opposite nectophores, the larger of which embraces the smaller, form together a hydrœcial canal, in which the siphosome may be partly retracted. *Apolemia* bears to *Hippopodius* much the same relation as *Dicymba* exhibits to *Praya*. The large ventral groove of each nectophore here embraces a corresponding part of two obliquely opposite nectophores, a superior and an inferior (compare 8, p. 314). The form of the umbrella is similar to that of *Hippopodius*, and so also is the arrangement in the biserial nectosome. The mouth of the nectosome is relatively small, and directed downwards and outwards. The four radial vessels of the powerful subumbrella, connected by a small ring-vessel above the insertion of the velum, are strongly differentiated. The two sagittal canals (shorter ventral and longer dorsal) make a simple curve in the median plane of the nectophore, whereas the two lateral canals (right and left) are much prolonged and have a complicated course, with two to four undulate turnings; from the

uppermost turning often arises a series of short diverticula or villiform lateral branches (compare **4**, p. 18, Taf. vi. figs. 6–9, and **8**, p. 315, Taf. xii. fig. 7).

Siphosome.—The tubular trunk beyond the nectosome in all Apolemidæ is very long, and attains in the extended state a length of two or three feet or more. It bears a great number of ordinate cormidia, separated by long internodes of equal length. These are naked in *Dicymba* and *Apolemia* (similar to those in the polygastric Calyconectæ), whilst they are densely covered with innumerable bracts in *Apolemopsis* (as in *Agalmopsis*). The trunk is much shortened in the highly contracted state; the internodes then nearly disappear and the entire corm is covered by a carapace of scales, the densely crowded bracts.

Cormidia.—The two subfamilies of Apolemidæ are similar in the general conformation of the cormidia, and the structure of their single parts; they exhibit, however, an important difference in their composition. Each cormidium of the Dicymbidæ has only a single siphon and a single cyston, surrounded by numerous bracts and palpons; whereas in the Apolemopsidæ each cormidium possesses several (two to four or more) siphons, and the same number of cystons. The Dicymbidæ, therefore, have monogastric cormidia (like the Rhizophysidæ, Pls. XXIII., XXIV.), whilst the Apolemopsidæ possess polygastric cormidia (like the Salacidæ, Pl. XXV.). The number of bracts (usually twenty to forty in each cormidium) seems to be in all Apolemidæ about the same as the number of palpons and palpacles, so that perhaps each bract, together with an appertaining palpon and a single palpacle, represents originally a medusome, the organs of which are modified and dislocated; the bract corresponding to the umbrella, the palpon to the manubrium, and the palpacle to the single tentacle.

Bracts.—The hydrophyllia, as the metamorphosed umbrellæ of the medusomes, exhibit in all Apolemidæ hitherto observed the same peculiar form. They are ovate, club-shaped or pyriform, with rounded distal end and pointed proximal end; the latter is attached to the stem by a short pedicle, which is raised or lowered by a muscle. The convex outside (exumbrella) is armed with numerous whitish patches composed of cnidocysts, whilst the concave inside (subumbrella) is smooth. Near the latter there runs in the median line of the bract a simple bracteal canal, which arises from the axial canal of the trunk and ends blindly towards the distal end; sometimes it is provided, near the latter, with a small cæcal diverticulum directed towards the lower face (compare **7**, p. 320, Taf. xviii. figs. 1–3, and **8**, p. 316, Taf. xii. fig. 8).

Siphons.—The feeding polypites have in all Apolemidæ the same structure; the single siphon in the monogastric cormidia of *Dicymba* (Pl. XVIII. figs. 1, 2, *s*), however, is relatively larger, whilst the several siphons (two to four or more) in the polygastric cormidia of *Apolemia* are smaller, and are more like the palpons. The four segments of the siphon (Pl. XVIII. fig. 2, *s*) are usually distinct, and already very well represented in the oldest figure, given by Lesueur. The short pedicle, to which is attached the single

long tentacle (*t*), bears a hemispherical basigaster with a thick exodermal wall full of cnidocysts (*sb*). The large ovate or fusiform stomach (*s*) possesses four or six strong hepatic ridges (*sh*), composed of small villi and coloured red or brown (four in *Dicymba* and *Apolemopsis*, six in *Apolemia*). The long tubular proboscis (*sr*) bears a corresponding number (four or six) of longitudinal muscle-bands, and at the distal mouth a similar number of small rounded lobes.

Tentacles and Palpacles.—All Apolemidæ bear very numerous long and thin filaments, which are usually described as tentacles. According, however, to the general definition, which holds good for other Siphonophoræ, we may call only those larger filaments which are attached (singly) to the base of the siphons tentacles, whilst we call the similar smaller filaments which arise from the base of the cystons and palpons palpacles (thus a single one from each polypite). The structure is otherwise the same in both. They are simple, thin and long cylindrical tubules, closed at the distal end, opening into the pedicle of the polypite at the proximal end; they never bear lateral branches. The structure of the cylindrical wall is the usual one, a vibratile entodermal epithelium inside, a cnidal exodermal epithelium outside, and between them an elastic fulcrum, which bears inside a thin plate of ring-muscles, and outside numerous radial ribs covered with longitudinal muscles. The cnidocysts are larger and more numerous in the abaxial part of the exoderm and towards the distal end, often arranged in two or four longitudinal series.

Cystons.—Each siphon or feeding polypite of the Apolemidæ is associated with a cyston or excreting polypite (fig. 2, *y*). The Dicymbidæ, therefore, have in each monogastric cormidium a single cyston, the Apolemopsidæ in each polygastric cormidium several cystons, two to four or more. The cystons or "anal vesicles" are intermediate in size between the larger siphons and the smaller palpons, and at once distinguished from both by the dark (red or brown) colour of their nontransparent body. Their four segments are usually not so distinct as in the similar but more fully developed siphons; the hepatic ridges of the latter are replaced by series of glandular villi, secreting a granular red or brown pigment-mass. This is accumulated in a vesicular terminal diverticulum of the proboscis, and may be ejected through a small opening of the latter (anus).

Palpons.—The Apolemidæ possess exceedingly numerous tasters or palpons, usually twenty to forty or more in each single cormidium, therefore several thousands, when the number of cormidia exceeds a hundred, as is often the case in corms of two or three metres in length. The palpons are slender, very mobile, cylindrical or spindle-shaped tubes, closed at the pointed distal end, which is richly armed with cnidocysts and long cnidocils. The middle part of the utricle exhibits sometimes four or six longitudinal ridges, corresponding to the hepatic stripes of the siphons and the excretory pigment-stripes of the cystons. The pedicle of each palpon bears a long, very thin palpacle, similar to that of the cyston (compare 7, pl. xviii. fig. 4, and 8, Taf. xii. p. 10).

Gonophores.—The medusiform gonophores arise in clusters from branched gonostyles, and possess in both sexes of the Apolemidæ a well-developed umbrella with four radial canals and a connecting ring-canal; *Dicymba* (Pl. XVIII. figs. 4, 6) is besides distinguished by the possession of four rudimentary tentacles which are placed at the distal end of the radial canals and bear a red ocellus (as in *Desmophyes* and *Lilyopsis*). The ovarium (or the manubrium of the female Medusa) includes a single large ovule surrounded by an irregular network of spadicine canals (figs. 3, 4). The spermarium (or the manubrium of the male Medusa) is a large club-shaped sac with a central spadix (figs. 5, 6). The corms of *Apolemia* are dicœcious and bear in each cormidium a single gonodendron, all of the same sex in one corm. The corms of *Apolemopsis* and *Dicymba* are monœcious and bear in each cormidium two gonodendra, a male and a female; they arise separately from the common trunk on the base of the cormidium.

Synopsis of the Genera of Apolemidæ.

I. Subfamily Dicymbidæ. Nectosome with two opposite nectophores only. Cormidia monogastric, each with a single siphon and cyston.	Internodes of the siphosome naked. Corms monœcious. Cormidia monoclinic, with two gonochoristic gonodendra (a male and a female), ...	39. *Dicymba*.
II. Subfamily Apolemopsidæ. Nectosome with two opposite rows of nectophores. Cormidia polygastric, each with several siphons and cystons.	Internodes of the siphosome naked. Corms dicœcious. Cormidia diclinic, with a single gonodendron (either male or female),	40*a*. *Apolemia*.
	Internodes of the siphosome covered with bracts. Corms monœcious. Cormidia monoclinic, with two gonochoristic gonodendra,	40*b*. *Apolemopsis*.

Genus 39. *Dicymba*,[1] Haeckel, 1888.

Dicymba, Hkl., System der Siphonophoren, p. 39.

Definition.—Apolemidæ with two large opposite nectophores only. Internodes of the siphosome naked. Cormidia monogastric and monoclinic, each with a single siphon and cyston, and with two separate gonodendra, a male and a female. Corms monœcious.

The genus *Dicymba* is represented by a new interesting Apolemid, which I observed living during my voyage through the Indian Ocean, from Aden to Bombay, in November 1881. The special organisation of the single parts which compose the polygastric corm, is similar to that of the common *Apolemia*; but their disposition and number are different. The nectosome of *Dicymba* is composed of two large opposite nectophores only (as in *Praya* and *Diphyes*). The cormidia, which are separated by long free internodes, are monogastric, each provided with a single siphon and a single cyston only, besides numerous palpons. The medusiform structure of the gonophores is also peculiar. These differences seem to be so important, that *Dicymba* might be separated from the true Apolemidæ as the representative type of a new family Dicymbidæ.

[1] *Dicymba*=Double boat, δικύμβα.

Dicymba diphyopsis, n. sp. (Pl. XVIII. figs. 1–7).

Habitat.—Indian Ocean, between Aden and Bombay, November 1881 (Haeckel).

Nectosome (fig. 1).—The swimming apparatus is composed of a small pneumatophore placed at the top of the stem, and of two large opposite nectophores beyond it. These are slightly different in size, and rather similar to the nectocalyces of *Praya* (Pl. XXXI.) in form, structure, and arrangement, so fitting one into another, that the two longitudinal ventral wings of the larger embrace the opposite wings of the smaller swimming-bell. The subcylindrical hydrœcial canal, formed by the two longitudinal ventral grooves, is traversed by the apical part of the trunk, and embraces a great part of the retracted siphosome. This attains in the fully expanded state a length of about half a metre.

Pneumatophore.—The float is a pyriform vesicle of 10 mm. in length and 6 mm. in breadth. Its apical part is covered with red pigment (fig. 1, *p*). The pneumatosac is a simple invagination of the exoderm of the stem-top, and not connected with the surrounding pneumatocodon by radial septa (compare above, p. 206).

Nectophores.—The two opposite nectophores are of equal form, but a little different in size, 40 mm. to 50 mm. long, 25 mm. to 30 mm. broad. Their form is ovate, with rounded apex and truncate base. The dorsal or abaxial side is evenly convex, without edges, but with a number of flat roundish tubercles, which bear white patches composed of cnidocysts. The ventral or axial side is concave, with a broad longitudinal groove bounded by two prominent lateral wings. In the upper third of the groove, midway between the two wings, arises a short, obliquely triangular lamella, the pedicle of the nectophore. The apex of this triangular pedicle is inserted near the apex of the trunk, somewhat below the base of the pneumatophore. The larger nectophore embraces by its ventral groove the opposite groove of the smaller in the same way as is described above in the case of *Praya galea* (Pl. XXXI. figs. 1–7 .

Nectosac.—The umbrellar cavity occupies about two-thirds of the nectophore, and is subspherical in the larger proximal half, subcylindrical in the smaller distal half. The opening of the latter is surrounded by a broad velum (fig. 1, *v*). The muscle-plate of the subumbrella is strong. The nectocalycine duct arising near the top of the stem, passes downwards through the pedicle of the nectophore and ends in the upper third of the dorsal median line of the subumbrella. It divides here into four radial canals of very different lengths; the ventral is about half as long as the dorsal, and both are shorter than the two paired lateral canals (right and left); these are four times curved in different directions and form the four loops figured in fig. 1, *n*. All four canals inosculate in the circular canal of the umbrella margin at equal distances.

Siphosome.—The long and thin tubular trunk of the siphosome had in the single specimen observed, in the fully expanded state, a length of 40 to 60 cm. It bore (besides

a number of buds in the uppermost part, beyond the nectophores) a series of a dozen fully-developed cormidia. The internodes of the trunk between these were naked, and had a length of 4 to 5 cm. In the contracted state the trunk was so shortened that the naked internodes disappeared, and the cormidia formed a continuous clustered mass; the upper part of this was hidden in the space between the ventral grooves of the two nectophores, comparable to a hydrœcium.

Cormidia (fig. 2).—Each cormidium is composed of a single siphon with its tentacle; a single cyston with a palpacle; a bunch of palpons, each with a palpacle (ten to twenty); a clustered mass of club-shaped bracts (fifteen to twenty-five); and a pair of clustered gonodendra, a male and a female. We may suppose that each bract is the reduced umbrella of a medusome, the manubrium of which is either a siphon, or a cyston, or a palpon; each one is provided with a tentacle or a palpacle. In this case the number of sterile medusomes in each cormidium would be fifteen to twenty-five. The number of sexual medusomes is much larger since the male as well as the female gonodendron is composed of twenty to thirty or more clustered gonophores.

Bracts (fig. 2, *b*).—The hydrophyllia, fifteen to twenty-five in each cormidium (besides numerous small buds of young bracts), form together a clustered mass which covers and protects the dorsal or superior side of each cormidium. The form and structure of the bracts are nearly the same as in the common *Apolemia*. They are club-shaped or pyriform bodies 15 to 25 mm. in length and 10 to 15 mm. in breadth, rounded at the thickened distal end, pointed at the basal end, where they are attached to the trunk by a short mobile pedicle. Their convex outer face is covered with white patches composed of cnidocysts. Near the concave inner face there runs along the median line a simple bracteal canal, which ends blindly near the distal end.

Siphons (figs. 1, 2, *s*).—The single siphon, which represents the only feeding person of each cormidium, is rather large, in the expanded state 20 to 30 mm. long and 4 to 8 mm. thick. It has a yellowish colour, and exhibits the usual four segments distinctly; a slender pedicle, to which the tentacle is attached; a pyriform thick-walled basigaster (*sb*), the exoderm of which contains masses of thread-cells; an ovate or spindle-shaped stomach, distinguished by four strong undulate liver-ridges of a red-brown colour (*sh*), and a muscular proboscis, in the expanded, very contractile wall of which four longitudinal muscle-bands can be distinguished (*sr*). The distal mouth opening may be expanded in form of a broad suctorial disc, which is sometimes circular, at other times provided with four or eight slight mouth lobes.

Tentacles (figs. 1, 2, *t*) *and Palpacles* (figs. 1, 2, *r*).—The single tentacle which is attached to the base of each siphon, is a long, simple, cylindrical filament, beset with two longitudinal rows of cnidocysts. It has nearly the same structure as the similar palpacles attached to the cystons and palpons; these, however, are smaller, much thinner, and less developed (compare above, p. 208).

Cystons (figs. 1, 2, *y*).—Each cormidium possesses a single cyston or anal vesicle, attached to the trunk near the base of the siphon. It is smaller than the siphon, but larger than the palpons, and at once distinguished from both by its deep red colour. The cyston is a slender spindle-shaped tube with two slight constrictions and a middle dilatation. This corresponds to the stomach of the siphon, and is densely covered internally with red glandular villi. The granular pigment secreted by these is accumulated in a head-like terminal expansion of the distal proboscis, and thrown out by a small terminal opening, the anus. The slender basal pedicle of the cyston bears a simple palpacle, of the same shape as that of the palpon.

Palpons (figs. 1, 2,).—The tasters occur in each cormidium nearly in the same number as the bracts, ten to twenty or more, besides numerous small buds of young ones. They are slender cylindrical or spindle-shaped tubules, very extensile and contractile, and as in *Apolemia* have a restless dashing motion. The closed distal end of each palpon is pointed and richly armed with cnidocysts and palpocils. The thinner and pediculate basal end opens into the axial canal of the trunk, and bears a long and thin palpacle (*r*), similar to that of the cyston.

Gonodendra.—Each cormidium is hermaphrodite (monoclinic) and bears two clustered gonodendra, a male and a female; they arise separately from the trunk, both near the base of the cyston. The female gonodendron (fig. 3) is composed of twenty to thirty gynophores, besides numerous small buds. The male gonodendron (fig. 5) is smaller and bears only fifteen to twenty androphores. The umbrella of the gonophores is in both sexes well developed, with four radial canals, and a circular ring-canal on the margin; the latter bears, at the distal end of the four radial canals, four small tubercles with a red pigment-spot, which are rudiments of reduced tentacles, with a basal ocellus. The gynophores (fig. 4) have a campanulate umbrella and a colourless subspherical manubrium, which contains a single large ovulum, surrounded by spadicine canals. The androphores (fig. 6) have a more oblong umbrella and a club-shaped manubrium of a bright red colour; its central spadix is surrounded by a thick layer of sperm.

Genus 40*a*. *Apolemia*,[1] Eschscholtz, 1829.

Apolemia, Esch., System der Acalephen, p. 143.

Definition.—Apolemidæ with a biserial nectosome, composed of two opposite series of nectophores. Internodes of the siphosome naked. Cormidia polygastric and diclinic, each with several siphons and cystons, and with a single gonodendron, either male or female. Corms dicœcious.

The genus *Apolemia* was established by Eschscholtz for that North Atlantic form which Lesueur had figured in 1813 under the name *Stephanomia uviformis* (not

[1] *Apolemia* = Pacific, ἀπόλεμος.

uvaria!). Kölliker (4) and the following observers, who described in the years 1853 to 1863 the Mediterranean *Apolemia uvaria* (called *Agalma punctata* by Vogt, 6), supposed that these two species were identical. But a comparison of both has convinced me that they belong to different genera. The internodes of the long tubular siphosome are naked in the Mediterranean *Apolemia uvaria*, whilst they are densely covered with bracts in the North Atlantic *Apolemopsis uviformis* (or *Apolemia lesueuria*); the corms are dicœcious in the former, monœcious in the latter. I retain, therefore, the name *Apolemia uvaria*, now generally accepted for the Mediterranean form, for this type of the genus, the gigantic corm of which attains a length of two or three metres and more. Compare the descriptions of the corm by Vogt (6), Gegenbaur (7), and Leuckart (8), of the nectophores by Kölliker (4), and of the gonophores by Claus (35).

Genus 40*b*. *Apolemopsis*,[1] Brandt, 1835.

Apolemopsis, Brandt, Prodromus, **25**, p. 36.

Definition.—Apolemidæ with a biserial nectosome, composed of two opposite series of nectophores. Internodes of the siphosome densely covered with bracts. Cormidia polygastric and monoclinic, each with several siphons and cystons, and with two separate gonodendra, a male and a female. Corms monœcious.

The genus *Apolemopsis* was established by Brandt (25) for an Apolemid, which Mertens had observed in the Tropical Pacific, near the Caroline Islands. Comparing his accurately drawn figures with the splendid pictures which Lesueur had given in 1813 of his North Atlantic *Stephanomia uviformis*, I suppose that these two similar forms may be distinguished as two species of one genus. This genus, for which I retain Brandt's name *Apolemopsis*, seems to differ from the true *Apolemia* (*uvaria*) in two essential characters. The entire siphosome of *Apolemopsis* is densely covered with innumerable bracts, as in *Agalmopsis*, whilst in *Apolemia* the long internodes between the cormidia are naked, as in the Diphyidæ. The corms of the former are monœcious, those of the latter dicœcious. Each siphon possesses in *Apolemopsis* four liver-ridges (as in *Dicymba*), in *Apolemia* six. A further careful comparison, however, of the two genera, as well as of the different species belonging to them, is necessary by future observers.

Family XIII. Agalmidæ, Brandt, 1835.

Agalmidæ, Brandt, Prodromus, &c., 1835, **25**, p. 34.
Stephanomidæ, Huxley, Oceanic Hydrozoa, 1859, pp. 70, 72.

Definition.—Physonectæ polygastricæ, with a long tubular stem of the siphosome, bearing numerous siphons, palpons, and bracts, each siphon provided with a branched

[1] *Apolemopsis* = Similar to *Apolemia*.

tentacle. Nectosome biserial, with two opposite rows of nectophores. Pneumatophore with radial pouches (compare Pls. XIV.–XVII.).

The family Agalmidæ, the largest of all Physonectæ, comprises those polygastric "Physophoridæ" which possess a biserial nectosome, and at its apex a pneumatophore with radial pouches; the long tubular stem of the siphosome bears numerous siphons, bracts, and palpons; the tentacles are always branched, with a single series of tentilla.

The genera and species of Agalmidæ are rather numerous, and widely distributed over all seas; they occur in the Arctic as well as in the temperate zones, but mostly in the Tropics. The majority, however, occur only at certain seasons and not in great numbers; nearly all are extremely delicate and sensitive, and the component parts easily detached from the stem. Most of the older observers, therefore, have only described fragments or single isolated pieces. A further great obstacle to accurate examination is the extraordinary mobility and contractility of most Agalmidæ.

The first figures and descriptions of Agalmidæ were given by Péron and Lesueur (**14**, *Stephanomia*, 1807), and by Eschscholtz (**21**, *Agalma*, 1825). Lesson (**3, 22**) and Quoy and Gaimard (**2, 19, 20**) published figures and descriptions of numerous scattered pieces, but without great value. Brandt in 1835 described *Agalma mertensii* from an excellent (though alas unpublished) figure by Mertens (made in 1827), and founded upon it the family Agalmidæ (**25**). Sars in 1846 published accurate figures of the northern *Agalmopsis elegans*. The excellent observers in the sixth decade of our century (1853–1859), Kölliker (**4**), Vogt (**6**), Leuckart (**5, 8**), Gegenbaur (**7, 10**), and Huxley (**9**), greatly advanced our knowledge of the Agalmidæ, which were also called Stephanomidæ (including *Forskalia*). Some new interesting species have been described recently by Claus (**74, 75**), Fewkes (**42–45**), &c. In general, however, there yet remains much to be done towards a more accurate knowledge of this important and interesting family.

My own observations on numerous different Agalmidæ were commenced in 1859 in Messina, and continued in the winter of 1866–67 in the Canary Islands; but the richest harvest was found during my residence in Ceylon, where I had the opportunity of observing several new and interesting forms. The Challenger collection contained many isolated and scattered portions of detached parts of Agalmidæ, but no complete specimens of any value.

Nectosome.—The swimming apparatus of the Agalmidæ is composed of a small apical pneumatophore and of two opposite rows of large alternating nectophores. These are so arranged around the axial trunk, that the apical part of each nectophore fits into the interval between two neighbouring nectophores of the opposite row, a superior and an inferior. The trunk itself, therefore, is spirally twisted, since the insertions of all the nectophores originally form a single straight series in the ventral median line of the trunk. The spiral line usually is læotropic (or a lambdoid spiral), therefore opposed to the spiral of the siphosome, which is (perhaps always) dexiotropic (or a deltoid spiral). The number of nectophores is in most species ten to twenty, but in some smaller forms only four

or six, in the largest forty to fifty or more. The pedicles of the nectophores are usually small, and easily detached from the axial trunk.

Pneumatophore.—The aëriferous float in all Agalmidæ is small, often very small in comparison to the nectophores. It is placed at the top of the trunk, the uppermost part of which is sometimes prolonged, so as to form a contractile pedicle to the float; in this case it is able either to pass forward over the uppermost nectophores, or at other times to be retracted between them. Usually the float is ovate, spindle-shaped or pyriform. Its top seems to be closed, without a constant opening; it is often coloured by a small red or brown pigment-spot, and sometimes this forms a regular octoradial star, the centre of which is colourless, like an ocellus. The lower half of the pneumatophore often exhibits a number of equidistant longitudinal ribs, the insertions of the radial vertical septa which connect the outer with the inner wall, and divide the cavity of the pneumatophore into radial pouches; the number is usually eight, sometimes variable (seven or nine), at other times four, six or twelve; the upper portion of the septa passes over into the circular muscular ring, which surrounds the pylorus infundibuli like a sphincter or diaphragm.

Nectophores.—Although the form of the nectocalyces in the numerous Agalmidæ is very manifold, it is always developed from the same original type, and represents only variations of a single type, which is defined by their alternately pinnate arrangement on the axial trunk of the biserial nectosome. The quadriradial umbrella of the nectophores is always bilateral, with a complete symmetry of both its halves. It is more or less depressed in the sagittal direction, from the convex dorsal to the concave ventral side, so that the frontal or transverse axis is longer than the sagittal. The principal axis is sometimes longer, at other times shorter than the frontal; it is directed towards the axial trunk more or less obliquely, and intersects it at a variable angle; but the apical pole (with the pedicle) is always situated more highly than the basal pole (with the ostium); the narrower ostium is directed outwards and downwards. The pedicle of the nectophore, which arises in the median line of its lower or ventral side, is a short triangular lamella; its proximal apex is inserted on the ventral median line of the axial trunk. This latter is constantly embraced by a pair of large auricles, apical wings or frontal horns, which arise from the dilated lateral parts of the nectophore. The sharp proximal edges of the wedge-shaped horns fit so one over another between the two opposite nectophores, that the axial part of the nectosome in the lateral view exhibits a very characteristic zigzag shape.

Nectosac.—The subumbrella occupies sometimes scarcely the distal half of the nectophore, at other times its greater part. It exhibits constantly the same bilateral form, with a complete symmetry of both lateral halves, and is depressed in sagittal, dilated in frontal direction. Usually it is divided into three parts, an odd median part with the basal ostium, and two paired lateral parts which correspond to the two frontal horns. The distal ostium is usually small. The four radial canals of the nectosac are

always in two very different pairs; the two opposite sagittal canals (shorter ventral and longer dorsal) are simply curved in the median plane of the nectosac; the two paired and equal lateral canals (right and left) are much longer, and more or less curved in different directions, usually with three or four roundish loops, the course of which is often characteristic of the single species. The top of the subumbrella, where the four radial canals arise from the peduncular canal, is dislocated more or less towards the ventral side. The points where the four radial canals open into the circular ring-canal, above the insertion of the small velum, are sometimes marked by four red pigment-spots; at other times only two or three ocelli are preserved (an odd dorsal and two paired lateral); the fourth (ventral) has disappeared (Pl. XVIII. figs. 8, 9).

Siphosome.—The external form and internal structure of the siphosome, as well as the character of the motions and habits, are so different in the various Agalmidæ, that we may divide this large family for that reason into two subfamilies: Crystallodinæ and Anthemodinæ (**25**, pp. 39, 40). The siphosome of the Crystallodinæ (*Agalma, Crystallodes,* &c.) is relatively short, about as long as or little longer than the nectosome; it is very little expansive and contractile, and distinguished by a peculiar rigidity, caused by the peculiar shape and junction of the bracts; these are very thick and firm, prismatic or wedge-shaped, cartilaginous portions, so densely packed one over the other that the intervals nearly disappear; they form a complete carapace of scales around the trunk even in its most expanded state. The motions of the siphosome in the Crystallodinæ, therefore, are very weak and inconsiderable (compare Pl. XVII.).

The second form of the siphosome, very different from the first, is represented by the Anthemodinæ. It is very long and movable, usually much longer than the nectosome, and in the expanded state often many times longer. The tubular trunk of this siphosome is very extensible and contractile, and in the expanded state only loosely covered by the bracts; these are usually thin scales, often foliaceous, and separated by dilatable intervals. The motions of the siphosome in these Anthemodinæ (*Halistemma, Agalmopsis,* &c.) are usually very active and quick; the expanded stem may be suddenly contracted and then occupy a much smaller space (one-tenth or less of the expanded corm) (compare Pls. XIV.–XVI.).

Cormidia.—The polymorphous persons and their organs are arranged and grouped in the siphosome of the Agalmidæ in a very variable order; generally we may distinguish ordinate and irregular cormidia; there are, however, intermediate stages between these two types. Perhaps the whole family may be divided according to this difference into two subfamilies—Stephanomidæ (with ordinate cormidia) and Halistemmidæ (with irregular cormidia); in both subfamilies occur Crystallodinæ (with rigid siphosome) and Anthemodinæ (with movable siphosome). The ordinate cormidia of the Stephanomidæ are equidistant and separated by internodes of equal length, which are only covered with bracts. They exhibit a most primitive and simple arrangement

in *Stephanomia* and *Crystallodes*, where they form a single rectilinear series in the ventral median line of the rigid trunk; all parts of the cormidia here hang down from its ventral or inferior side, whilst the dorsal or superior side is only covered with bracts (Pl. XVII. fig. 1). *Anthemodes* and *Cuneolaria* differ from the former in the spiral twisting of the prolonged and very movable stem; the cormidia, therefore, are turned in all directions; but they are also separated by long internodes which are only covered with bracts (Pl. XIV.). Each cormidium is composed in these four genera of a single siphon with its tentacle; one or more palpons (or cystons), usually each with a palpacle; a group of bracts, and a monoclinic pair of distylic gonodendra (a male and a female) (Pl. XV. fig. 5, *f*, *h*; Pl. XVII. fig. 4, *f*, *h*).

The Halistemmidæ—or the Agalmidæ with dissolved cormidia—comprise the majority of this family, viz., all the genera except the four above mentioned. The polymorphous persons and their organs are here more or less dislocated and scattered; the palpons and gonostyles arise (singly or united in groups) directly from the trunk of the siphosome, not from the base of the siphons as in the Stephanomidæ. Usually also here the internodes between the siphons are of equal length; they are, however, not free, but covered with palpons, cystons, and gonodendra variously arranged: sometimes rather regularly (as in *Phyllophysa*, *Cupulita*, &c.); at other times very irregularly (as in *Halistemma*, *Agalmopsis*, &c.). A peculiar structure already described by Eschscholtz (1, p. 150) is developed in *Agalma*, where the bracts compose a scale, a carapace with a central cavity, or an axial hydrœcium into which the distal part of the siphosome may be retracted (Pl. XVIII. fig. 8).

Bracts.—The hydrophyllia or "covering scales" in all Agalmidæ are very numerous, often several hundreds, in the largest forms more than a thousand. They arise usually not only from the nodes of the trunk, where the siphons are attached, but also from the internodes between them. The carapace of scales, which is composed of the jointed bracts apposed one to another, is always complete in the contracted state of the siphosome, and often also in the expanded state. Their special form and arrangement are very different in the various Agalmidæ. Generally the bracts are thick, prismatic or wedge-shaped in the Crystallodinæ, where they cover the rigid trunk so densely that their intervals nearly disappear and the siphosome loses its contractility. In the Anthemodinæ, on the other hand, where the stem is very extensile and contractile, the bracts are usually thin, foliaceous or squamous, and the intervals between them of very variable size. The general form of the bracts is sometimes ovate, lanceolate, or rhombic, at other times trigonal, tetragonal, or pentagonal, often with three to five (rarely more) prominent teeth at the distal margin. Usually the superior or outer face is more or less convex (often with prominent ribs, armed with cnidocysts), the inferior or inner face concave; near this runs in the median line of the bract the simple blind bracteal canal. The clear and hyaline jelly-substance of the

colourless bracts is usually more or less cartilaginous, sometimes soft; it is thickened in the middle part and often towards the distal edge. The proximal base tapers towards the small movable pedicle, which attaches the bract to the trunk.

Siphons.—Each cormidium of the Agalmidæ possesses a single siphon only, and this is placed originally always (and in the ordinate cormidia permanently) at its distal or lower end. The four segments of the siphon exhibit a varying degree of development. The pedicle (*sp*) is usually short, but sometimes prolonged (*e.g.*, in *Lychnagalma*). The basigaster (*sb*) is usually small, sometimes rudimentary. The stomach (*sm*) in most Agalmidæ is large and provided with longitudinal equidistant liver-ridges, usually of a red or brown colour. Their number in most Agalmidæ is eight, sometimes four (*Anthemodes*, Pl. XV. fig. 7), twelve (*Cuneolaria*), or sixteen (*Halistemma*, 6, pl. viii. fig. 1). Usually the hepatic ridges are continuous glandular bands, but sometimes composed of single villi arranged in longitudinal series. The proboscis (*sr*) is always a very muscular cylindrical tube, highly expansible. Its distal mouth is extremely variable in form and size; it may be expanded in the form of a very large and thin-walled suctorial disc, sometimes circular, at other times polygonal (often octagonal). Its edge is usually armed with cnidocysts.

Tentacles.—The single long tentacle, which is attached to the base of each siphon, exhibits the same essential structure in all Agalmidæ, but shows great variety in the form of its equidistant lateral branches. The various forms of these tentilla have been already employed by Eschscholtz (1829) and afterwards by Huxley (1859) for the distinction of genera. The simplest and most primitive form is found in *Halistemma;* the cnidoband is a simple, thickened, spirally convoluted dilatation of the middle part of the tentillum, with a double elastic band (or angle-band) on its ventral side, and a strong cnidobattery on the dorsal side; the terminal filament is a simple thin tubule, similar to the pedicle. Four other genera (*Stephanomia*, *Phyllophysa*, *Anthemodes*, and *Cupulita*) have the same form of the tentillum, but with this difference, that a campanulate involucrum arises from the distal end of the pedicle and encloses the proximal part of the cnidoband (Pl. XV. fig. 11). This involucrum is complete in four other genera (*Crystallodes*, *Agalma*, *Cuneolaria*, and *Agalmopsis*); the simple terminal filament in these is replaced by a tricornuate appendage, an odd median terminal ampulla, and two paired, often spirally coiled lateral horns (Pl. XVII.). The highest degree of development, finally, is attained by *Lychnagalma;* the long cnidoband, enclosed in a complete involucrum (or cnidosac), bears at its distal end a very large, hydrostatic, terminal ampulla surrounded by a corona of eight radial horns (Pl. XVI.).

Palpons.—All the Agalmidæ possess a number of hydrocysts on the siphosome, either true (mouthless) palpons, or excreting cystons (with a mouth). The distinction between them is often difficult and requires further accurate observations. Usually each cormidium (with a single siphon) possesses several (four to six or more) palpons; but sometimes

only a single one or a group of two. The palpons are united in a bunch, attached to the basal insertion of the siphon, in the ordinate cormidia of the Stephanomidæ; they are isolated, attached immediately to the trunk, and scattered between the siphons, in the dissolved cormidia of the Halistemmidæ; sometimes their succession is regular, at other times irregular. Usually one palpon (or cyston) is in direct connexion with the gonodendra, whilst others are independent of them. The palpons are thin-walled, cylindrical, very contractile and movable tubes, closed at the distal end, which is armed with thread-cells. Sometimes the distal part of the palpon is separated by an annular constriction and forms a subspherical cavity, in which a group of crystals or concretions (like an otolith) is turned round by the ciliated entoderm, as in an otocyst.

Cystons.—Hydrocysts with a terminal mouth opening, or cystons, occur very frequently (perhaps even constantly?) in the Agalmidæ; they were formerly confounded with the similar mouthless palpons. They are larger than the latter, with a thicker entoderm, which is partly glandular, and often coloured (red or brown). The fluid secretion, or the pigmented, granular or crystalline masses secreted by it, are ejected by the distal mouth, or rather the anal opening, which is closed by a muscular sphincter. Sometimes the distal part is separated from the dilated middle part by an annular constriction (Pl. XV. figs. 8, 9). I have never found more than a single cyston in each cormidium, whilst the number of palpons is usually large and variable.

Palpacles.—Many Agalmidæ, but not all, possess a number of long and thin palpacles, feeling or tasting filaments. Usually a single palpacle (or "accessory tentacle") is attached to the base of each palpon and probably also of each cyston. But in some species they have not been described; possibly they were either overlooked or lost accidentally. Each palpacle is a very slender cylindrical tubule, the muscular wall of which is very expansible and contractile, the cells of the exoderm covered with palpocils and partly containing small cnidocysts.

Gonostyles.—All the Agalmidæ have monœcious corms and monoclinic cormidia; each cormidium possesses a male and a female gonodendron. These arise sometimes from a common pedicle, at other times separated from two neighbouring gonostyles. The ordinate cormidia of the Stephanomidæ always bear a small pair of gonostyles, a male and a female, attached to their common trunk near the siphon. The loose cormidia of the Halistemmidæ, however, exhibit a variable arrangement. Sometimes a monoclinic pair of gonodendra, united with a palpon or cyston, arises from each internode, midway between two neighbouring siphons; at other times each internode bears two to four or more pairs of gonodendra; and sometimes their disposition is quite irregular, numerous male and female gonodendra being scattered irregularly along the whole trunk of the siphosome. Usually the gonodendra are small clusters, and their gonostyles simple or little branched. The female gonophores are smaller and more numerous than the male. Their umbrella is usually well developed, pedunculate, but sometimes rudimentary.

The ovaria are ovate or subspherical, each with a single large ovum only, which is often surrounded by an irregular net of spadicine canals (Pl. XV. fig. 15; Pl. XVIII. fig. 16). The spermaria are more oblong, spindle-shaped, cylindrical or club-shaped, with a simple central spadix (Pl. XV. fig. 14; Pl. XVIII. fig. 17).

Ontogeny.—The development of the fertilised egg and the peculiar metamorphosis of the larva (*Physonula*) arising from it, is known only in a few Agalmidæ. It was first described by myself in 1869, in *Crystallodes rigidum* (**84**, Tab. vi.–xiii.); afterwards by Metschnikoff, in 1874, in *Halistemma rubrum*, *Cupulita picta*, and *Agalmopsis sarsii* (**85**, Taf. viii.–xii.), and finally by Fewkes in *Agalmopsis elegans* (**89**).

Synopsis of the Genera of Agalmidæ.

I. Subfamily CRYSTALLODINÆ. Siphosome short and rigid, about as long as the nectosome. Trunk of the siphosome stiff, scarcely contractile, densely covered with thick prismatic or spheroidal bracts.	Cormidia ordinate. Internodes free, covered only with bracts. Palpons and gonostyles at the base of the siphons.	Tentilla with a simple terminal filament,		41. *Stephanomia.*
		Tentilla tricornuate, with a triple terminal filament,		42. *Crystallodes.*
	Cormidia loose. Palpons and gonostyles attached to the internodes, between the siphons.	Tentilla with a simple terminal filament,		43. *Phyllophysa.*
		Tentilla tricornuate, with a triple terminal filament,		44. *Agalma.*
II. Subfamily ANTHEMODINÆ. Siphosome very long and movable, much longer than the nectosome. Trunk of the siphosome very extensible and contractile, loosely covered with thin scales or foliaceous bracts (rarely with prismatic bracts).	Cormidia ordinate. Internodes free, covered only with bracts. Palpons and gonostyles at the base of the siphons.	Tentilla with a simple terminal filament,		45. *Anthemodes.*
		Tentilla tricornuate, with a triple terminal filament,		46. *Cuneolaria.*
	Cormidia loose. Palpons and gonostyles attached to the internodes, between the siphons.	Tentilla with a simple terminal filament.	Cnidoband naked, without involucre,	47*a*. *Halistemma.*
			Cnidoband enveloped by a campanulate involucre,	47*b*. *Cupulita.*
		Tentilla tricornuate or multicornuate, with a triple or multiple terminal filament.	Terminal ampulla of the tentilla, with two lateral horns,	48. *Agalmopsis.*
			Terminal ampulla of the tentilla, with a corona of eight radial horns,	49. *Lychnagalma.*

Genus 41. *Stephanomia*,[1] Péron et Lesueur, 1807.

Stephanomia, Péron et Lesueur, Voyage aux terres australes.

Definition.—Agalmidæ with a short and rigid siphosome, the trunk of which is scarcely contractile. Bracts with small intervals. Cormidia ordinate, with free internodes, in a single, straight, ventral series. Tentilla with a simple terminal filament.

The genus *Stephanomia* is the oldest known form of Agalmidæ, and was founded in 1807 by Péron for an Australian Physonect, of which his collaborator Lesueur has left an excellent picture (**14**, pl. xxix. fig. 5). The figure represents the siphosome only, without the nectosome; but fortunately I had the opportunity during my residence in Ceylon (in December 1881) of examining a complete living specimen of a closely allied species. The cylindrical siphosome of this Indian *Stephanomia nereidum* had exactly the same form as that of the Australian *Stephanomia amphitrites* in Lesueur's figure, except the special form of the bracts; these are all tridentate in the latter, and arranged very regularly in four longitudinal series; whilst in the former they were provided partly with three, partly with five teeth, and arranged in six less regular series. The long internodes between the cormidia were free, and the yellowish gonostyles attached near the base of the red-coloured siphons. The biserial nectosome composed of twelve complete nectophores, had nearly the same form as that of *Crystallodes vitrea* (Pl. XVII. figs. 1–3). The position of the quietly swimming animal was the same as in Lesueur's figure, the trunk lying horizontally and the cormidia forming a rectilinear series on its ventral side; the siphons and tentacles, therefore, depending vertically. The same position is exhibited also by the similar Agalmid, which Huxley afterwards described as *Stephanomia amphitrites* (**9**, pl. vi.); but this has loose cormidia, and belongs probably to *Phyllophysa* (Genus 43).

Genus 42. *Crystallodes*,[2] Haeckel, 1869.

Crystallodes, Hkl., Entwickelungsgeschichte der Siphonophoren, p. 43.

Definition.—Agalmidæ with a short and rigid siphosome, the trunk of which is scarcely contractile. Bracts with small intervals. Cormidia ordinate, with free internodes, in a single, straight, ventral series. Tentilla tricornuate, with a terminal ampulla and two paired horns.

The genus *Crystallodes* was established by me in 1869 for an Atlantic Agalmid, the complete anatomy and ontogeny of which I observed in January and February 1867, during my residence in the Canary Island Lanzerote (**84**, p. 43, Taf. vi.–xiii.). Another closely allied species, differing from the Atlantic *Crystallodes rigida* mainly in the special form and arrangement of the bracts, was examined by me fifteen years after-

[1] *Stephanomia*=Corona, στεφάνωμα.

[2] *Crystallodes*=Crystal-shaped, κρυσταλλώδης.

wards in Ceylon, in January 1882; it is figured in Pl. XVII. of this Report. A third species may be an Agalmid, from the Tropical Pacific, the siphosome of which was figured by Lesson under the name *Plethosoma crystalloides* (**22**, pl. iv. fig. 2); the nectosome was detached in the only specimen observed. A fourth species is the North Pacific form, which Mertens observed in 1827 (lat. 42° N., long. 210° E.), and of which Brandt has given a short description under the name *Agalma mertensii* (**25**, p. 34). I had recently the opportunity of comparing the excellent pictures (unfortunately not published) which Mertens had executed most carefully from the living animal. They have convinced me that this *Crystallodes mertensii* is a peculiar species, differing in the special form of the nectophores and the arrangement of the bracts.

Crystallodes vitrea, n. sp. (Pl. XVII.).

Habitat.—Indian Ocean, Ceylon (Belligemma), January 1882 (Haeckel).

Nectosome (upper half of figs. 2, 3; fig. 1, lateral view, from the left side; fig. 2, dorsal view; fig. 3, ventral view).—The swimming apparatus in the single specimen observed was 14 mm. long, 8 mm. broad, and composed of an apical pneumatophore and of five pairs of opposite nectophores, besides some undeveloped buds on the base of the former. The axial trunk of the nectosome is a slender colourless tube, slightly undulating; its uppermost part is the thin pedicle of the pneumatophore, and was often stretched by the swimming animal in the usual position, with horizontally lying trunk (fig. 1); the pedicle of the pneumatophore was often bent upwards, and formed a right angle with the trunk, so that the float stood vertically. The column composed of the nectophores is a six-sided amphithect prism, corresponding to the regular union of the opposite pairs (fig. 6).

Pneumatophore (figs. 1–3, *p*).—The float is small, ovate or pyriform, with a red pigment-spot at the apex. Outside are visible four equidistant longitudinal lines, the insertions of the four vertical septa, which divide the pericystic cavity of the pneumatophore into four radial chambers.

Nectophores (figs. 1, 12, lateral view; figs. 2, 10, dorsal view; figs. 3, 9, ventral view; fig. 8, basal, fig. 7, apical view).—The cartilaginous umbrella of the nectophores is strongly compressed from both faces, so that the proportion of the frontal diameter to the principal and the sagittal axis = 3 : 2 : 1. The principal axis is nearly horizontal. The two large faces, upper dorsal and lower ventral, are nearly parallel and hexagonal in outline, the former slightly convex, the latter concave, with a prominent crest in the ventral median line; from this arises the short pedicle which attaches the nectosac to the trunk. The proximal half of the umbrella is wedge-shaped, thickened towards its equator, with a deep apical incision by which the two paired auricles or apical horns embracing the trunk are separated. The narrow lateral faces of the nectophores (right

and left) are triangular in the proximal half, quadrangular in the distal half, which is separated from the former by an equatorial crest. The distal (or basal) face, which encloses the small ostium of the nectosac (fig. 8, *v*), is small, and nearly square.

Nectosac.—The subumbrella, placed in the distal half of the nectophore, is cordiform or hammer-shaped, with an odd distal part bearing the mouth, and two paired lateral parts, which expand right and left; the three parts are subequal in size and similar in the quadrangular outline, seen from the face. The frontal axis of the nectophore passes through the broad proximal face of its subumbrella. The lateral view of the latter is oblong. The course of the four radial canals is as usual, straight in the two sagittal vessels (shorter ventral and longer dorsal), complicated and bent with three loops in the two paired lateral vessels (compare pp. 189, 216, and figs. 6–13).

Siphosome (lower half of figs. 2, 3; fig. 1, lateral view, from the left side; fig. 2, dorsal view; fig. 3, ventral view).—The siphosome of the single specimen observed possessed five fully-developed cormidia, and was in size (length as well as breadth) one and a half times as large as the nectosome; it equalled the latter in rigidity, and presented a glassy cylinder of 20 mm. in length and 12 mm. in diameter. Its axial trunk was nearly straight, and bore on its ventral median line the five equidistant ordinate cormidia. These occupied in the swimming animal (with horizontal trunk) only the ventral half of the siphosome, whilst its dorsal half was exclusively composed of bracts. All the siphons depended from the ventral side, and the long tentacles were prominent only on this side; in the same form which I have figured in the case of *Crystallodes rigida* (**84**, pl. x. figs. 65, 66). The same characteristic form is clearly represented in an excellent (unfortunately not published) figure of *Crystallodes mertensii,* drawn from life by Mertens in 1827.

Cormidia (fig. 4).—Besides numerous buds of undeveloped cormidia, placed at the top of the trunk of the siphosome (immediately beyond the nectosome), there were attached to the ventral median line of the trunk in the specimen figured five equal, well-developed and equidistant ordinate cormidia. Each of these is composed of the following parts arising from a common base:—(1) a siphon with its tentacle; (2) a group of four (sometimes three or five) palpons; (3) a group of bracts (of the same number?); (4) a male gonodendron; and (5) a female gonodendron. The equal intervals between the cormidia, or the free internodes of the stem, were only covered by thick prismatic bracts, densely attached one to the other.

Bracts (figs. 1–3, *b*; figs. 14–16).—The hydrophyllia are thick glassy polyhedral bodies of cartilaginous consistence, completely transparent, similar to colourless crystals. They are easily detached from the stem, and offer very different forms, partly subregular, partly irregular. The majority are wedge-shaped or obliquely pyramidal, with a tapering proximal end attached to the trunk, and a truncate facetted distal face. The upper face of the bracts is usually somewhat convex, the lower concave, and the outer

(or distal) face divided by several crests into trapezoidal facettes (mostly three, four, or five). Since the fundamental form of the cylindrical siphosome is bilateral, with symmetrical right and left halves, the paired bracts corresponding in both halves are so symmetrically disposed on both sides of the median plane (or the sagittal plane of the siphosome) that the panelled surface of the carapace offers an elegant and very regular pavement. Their special arrangement on the different sides of the siphosome is intelligible by comparison of figs. 1–3. Since the free terminal facettes on the surface of the scale-carapace are slightly concave, and their edges touch one another, the prominent crests between them form an elegant network over the whole surface. This pavement is in the Pacific *Crystallodes mertensii*, according to the beautiful figures of Mertens, still more regular and elegant (with subregular rhomboidal meshes, apparently arranged in eight longitudinal columns) than in our Indian *Crystallodes vitrea*. But also in this latter eight subregular alternating longitudinal columns may be distinguished. The entire cylindrical carapace is very firm and scarcely variable in form, since the protective scales may recede one from another only in a very slight degree. On the ventral side there remain small, free clefts between them, through which the tentacles proceed. Each bract encloses a simple blind canal, which runs in its median line, near to the lower concave surface.

Siphons (fig. 4, *s*).—The pedicle of the siphon is rather long and thin, the basigaster rudimentary. The wide cylindrical stomach exhibits eight longitudinal liver-ridges, each of which is composed of a series of conical villi (about ten or twelve large villi in each series). Each villus contains three to five roundish glossy and strongly refracting bodies (probably glandular vacuoles). The proboscis is long and very extensile, cylindrical, with eight strong longitudinal muscle-bands and eight alternating furrows inside. Its distal mouth is armed with cnidocysts and may be expanded as a suctorial disc.

Tentacles (figs. 1, 5).—The tentacle which arises from the pedicle of each siphon is very long, and bears a series of very numerous tentilla. The pedicle of the latter is also long, and often spirally coiled. It bears a purple cnidoband, which is included in a campanulate involucre and coiled up spirally in three to four turnings (fig. 5). The terminal ampulla (*ta*) is large, spindle-shaped, and covered with long vibratile cilia. On both sides of its base arise the two paired lateral horns, which are usually curved or spirally coiled (fig. 5, *tc*).

Palpons.—Each cormidium usually seems to possess four palpons attached to the trunk immediately at the base of the siphon. They are much smaller than the latter, simple, cylindrical, or spindle-shaped tubes, with a thin pellucid wall, very expansive and contractile. Their pointed distal end is closed and armed with a number of cnidocysts (fig. 4, *q*). The inner and the outer surfaces are covered with long vibratile cilia. I did not notice and so did not figure the presence of palpacles at the base of the palpons; but it may be that they were accidentally lost, or that I have overlooked them.

Gonodendra.—Each cormidium is monoclinic and bears two small grape-like, shortly pediculate gonodendra, a male (fig. 4, *h*) and a female (fig. 4, *f*). Their clustered gonophores are small and not very numerous. The ovaria, however, are more numerous and much smaller than the spermaria. The umbrella is well developed in both sexes, with four radial canals and a ring-canal. The manubrium of the gynophores is colourless, ovate, or subspherical, and contains only a single large ovum, surrounded by a network of irregular spadicine canals (similar to those of *Agalma*, Pl. XVIII. fig. 16). The manubrium of the androphores is much larger, cylindrical or spindle-shaped, milk-white, and includes an axial spadix; it is prominent more or less from the ostium of the umbrella in the ripe androphores (as in *Agalma*, Pl. XVIII. fig. 17).

Genus 43. *Phyllophysa*,[1] L. Agassiz, 1862.

Phyllophysa, L. Agassiz, Contrib. Nat. Hist. U. S., vol. iv. p. 369.

Definition.—Agalmidæ with a short and rigid siphosome, the trunk of which is scarcely contractile. Bracts with small intervals. Cormidia loose; palpons and gonostyles on the internodes, scattered between the siphons. Tentilla with a simple terminal filament.

The genus *Phyllophysa* was established in 1862 by L. Agassiz for an Agalmid, of which Quoy and Gaimard had figured a fragment only, under the name *Stephanomia foliacea* (2, p. 74, pl. iii. figs. 8–12). The description and the figures, however, which Quoy and Gaimard have left, are (as usual) far too incomplete and fragmentary to determine with certainty the true nature of the form captured near New Guinea. I retain the name of the genus, given by L. Agassiz, to designate that similar Agalmid, the siphosome of which Huxley described and figured under the name *Stephanomia amphitrites* (9, pl. vi.). It has loose cormidia, the palpons and gonophores being attached separately to the trunk, between the siphons. It differs, therefore, essentially from the similar Agalmid described under the same name by Péron and Lesueur; this has ordinate cormidia, with free internodes; and the gonophores are attached to the nodes at the base of the siphons (compare above, p. 221). *Phyllophysa* exhibits therefore the same relation to the true *Stephanomia* which *Agalma* has to *Crystallodes*. To avoid further confusion it seems advisable to call Huxley's form (9, pl. vi.) *Phyllophysa squamacea*.

Genus 44. *Agalma*,[2] Eschscholtz, 1825.

Agalma, Eschscholtz, Oken's Isis, 1825, p. 743; System der Acalephen, p. 150.

Definition.—Agalmidæ with a short and rigid siphosome, the trunk of which is scarcely contractile. Bracts with small intervals. Cormidia loose; palpons and

[1] *Phyllophysa* = Leaf-bladder, φύλλον, φῦσα.

[2] *Agalma* = Ornament, ἄγαλμα.

gonostyles on the internodes, scattered between the siphons. Tentilla tricornuate, with a terminal ampulla and two paired horns.

The genus *Agalma* was established by Eschscholtz in 1825 for a new Physophorid which he had observed living in the Northern Pacific (**21**, p. 743, Taf. v. fig. 17, and **1**, p. 150, Taf. xiii. fig. 1). The figure and description are very accurate, and this *Agalma okenii* must therefore be retained as the permanent type of the genus. It is closely allied to *Crystallodes*, but distinguished from this by the loose cormidia and the formation of a peculiar hydrœcium in the axis of the siphosome; the thick bracts are here so arranged that they enclose together a central cavity into which the contracted stem with the cormidia may be retracted. Eschscholtz had already pointed out this peculiar character as an essential difference from the similar *Stephanomia*. The same characteristic structure is very obvious in the new Indian species, which is described in the sequel as *Agalma eschscholtzii* (Pl. XVIII. figs. 8–17). A comparison of its loose cormidia with the ordinate cormidia of *Crystallodes* (Pl. XVII.) illustrates their distinction; the siphons and tentacles in this latter issue separately between the bracts, in a ventral series; whilst they issue in the former, crowded in a bunch, from the basal ostium of the hydrœcium. The same seems to be the case in three other species of this genus, which are described by Dana as *Crystallomia polygonata* (North Pacific, **73**, p. 459), by Huxley as *Agalma breve* (**9**, pl. vii.), and by Leuckart as *Agalma clavatum* (**8**, Taf. xiii. figs. 1–6). Later authors have described as *Agalma* a number of Agalmidæ which belong to other genera of this family.

Agalma eschscholtzii, n. sp. (Pl. XVIII. figs. 8–17).

Habitat.—Indian Ocean, Ceylon (Belligemma), December 1881 (Haeckel).

Nectosome (fig. 8, upper half).—The swimming apparatus, in the single specimen observed, was composed of an apical pneumatophore, and two opposite rows of nectophores, four in each row, besides some buds of undeveloped nectophores at the apex of the tubular trunk, at the base of the pneumatophore. The trunk was undulating, nearly zigzag, of a yellowish colour. The length of the nectosome is 40 mm., the sagittal axis 30 and the frontal axis 20 mm.

Pneumatophore (fig. 8).—The float is ovate or pyriform, about half as long as a nectophore, and covered with purple pigment-cells in the upper or apical half. The lower or distal half is yellowish, and exhibits eight equidistant longitudinal lines, the insertions of the eight vertical septa which divide the pericystic cavity of the pneumatophore into eight radial pouches.

Nectophores (fig. 8, lateral view; fig. 9, dorsal view).—The nectophores have the form of a broad and flat wedge, with a deep median incision on the two-horned

apical or proximal side. The two lateral sides (right and left) are irregularly triangular, with a prolonged proximal apex. The convex dorsal and the concave ventral faces are bilaterally symmetrical and nearly hexagonal; the two lateral edges of each hexagon are slightly convex; the two basal (or distal) edges are separated by the small ostium of the nectosac, and the two apical (or proximal) edges by the deep axial incision which embraces the stem. The two lateral horns or auricles, separated by the latter, are nearly rhombic. The thickness of the wedge-shaped nectophore increases gradually from the proximal apex towards the distal base, which is bilaterally truncated. In the median line of the concave ventral side of the nectophore arises the short triangular pedicle which attaches it to the stem.

Nectosac (figs. 8, 9, *w*).—The subumbrellar cavity of the nectophore is small and occupies only the middle part of its distal or basal half. It is oblongish in the profile view (fig. 8), bicornuate in the dorsal view (fig. 9). The two symmetrical apical horns are rounded. The basal mouth of the nectosac is narrow, and provided with three scarlet ocelli or pigment-spots at the base of the velum, just on the three points where three radial canals (the dorsal and the two lateral) inosculate into the marginal ring-canal. The fourth (ventral) canal possesses no ocellus. The course of the four radial canals is as usual (compare above, p. 216).

Siphosome (fig. 8, lower half).—The trunk of the siphosome is of about the same length as that of the nectosome, and densely covered with very thick and large bracts, which can recede only very little one from another, and permit, therefore, no considerable extension and shortening of the siphosome. This is almost globular, of 50 mm. diameter. The bracts are so arranged that the subspherical outside of the siphosome is completely loricated by the convex urticating abaxial face of the cartilaginous covering scales; these compose a continuous spiral, which is dexiotropic and ascends around the undulating axial trunk in four to six complete turnings. The trunk forms the axis of a subcylindrical or slenderly conical hydrœcium, *i.e.*, a cavity which serves for the reception of the contracted and retiring cormidia; this protective cavity is closed around by the carapace of the covering scales, and open only at the dilated distal end, whence the siphons and tentacles can proceed (fig. 8, *s*).

Cormidia.—The polymorphous persons which compose the siphosome, siphons, palpons, and gonostyles arise scattered and separately from the common trunk; I was however, not able, in the single specimen observed, to determine with full certainty their peculiar arrangement, and the true composition of the loose cormidia. It seemed to me that about half a dozen (or perhaps eight) siphons and tentacles arose from the lower or distal half of the trunk of the siphosome, intermingled with a number of palpons; whilst distylic gonodendra, male and female separately, were attached to its upper or proximal half, together with numerous palpons and palpacles, which were protruded between the scales. Unfortunately most of the appendages were detached

and the peculiar structure of the siphosome destroyed before I could begin its closer anatomical examination.

Bracts (fig. 8, *b*; figs. 10 and 11, dorsal view; figs. 12 and 13, profile view).—The covering scales which compose the firm carapace of the globular siphosome are very thick and hard wedges of cartilaginous consistence. Their thickness increases from the proximal pedicle towards the middle part and decreases again towards the distal part, which is usually trilobed or five-lobed. The form of the larger bracts is rather regular and symmetrical; there are, however, intermingled, mainly in the proximal part of the siphosome, numerous smaller bracts which have a more irregular form, and partly fill up the void intervals between the former. The majority of bracts were detached from the stem before I could examine their peculiar arrangement. Their lower or inner face is concave; and near to it runs in the median line the blind bracteal canal (figs. 10–13, *bc*); the upper or outer face is convex and usually provided with three or five prominent ribs; each rib is three-sided, prismatic, and bears on its prominent abaxial edge a series of large cnidocysts.

Siphons (fig. 8, *s*).—The feeding polypites, which proceed through the basal ostium of the hydrœcial cavity just described, are of medium size, and of the form usual in Agalmidæ. Their pedicle is long and slender, the basigaster small and ovate, the stomach fusiform and provided with four double rows of red-brown liver glands; the proboscis is slender, very protractile, and ends in a mouth, which may be expanded in the form of a circular or polygonal suctorial disc.

Tentacles (figs. 8, 14).—The long tentacle which is attached to the base of each siphon bears a series of very numerous tentilla. Each tentillum (fig. 14) is composed of a slender pedicle (*tp*) and a campanulate involucre (*th*) which encloses a purple spiral cnidoband (*tk*); this exhibits seven or eight spiral turnings, and bears at its distal end three appendages, a large spindle-shaped terminal ampulla (*ta*), and a pair of slender lateral horns (*tc*).

Palpons and Palpacles (fig. 8, *q*, *r*).—The tasters are very numerous and seem to be irregularly scattered over the entire stem of the siphosome, partly between the siphons and bracts, partly connected with the gonostyles. They are very slender pellucid tubes, cylindrical or spindle-shaped, closed at the apex, which includes a number of cnidocysts. From their tapering base arises usually (or always?) a long palpacle, a very thin and mobile tasting filament, of the usual shape. The palpons as well as their palpacles are stretched and protruded through the intervals of the bracts as well as through the basal opening of the hydrœcial cavity.

Gonodendra.—A small number of sexual clusters is attached to the trunk of the siphosome, mainly (or exclusively) to its upper or proximal half (?). The corm is monœcious, but the cormidia distylic, since each cluster contains gonophores of one sex only. The umbrella is well developed in the gonophores of both sexes, campanulate in

the female (figs. 15, 16), subcylindrical in the male (fig. 17); the four radial canals are connected at the ostium by a ring-canal. The ovate manubrium of the gynophores (fig. 15) includes a single large ovum only, surrounded by an irregular network of anastomosing spadicine canals (fig. 16, *cy*, compare p. 195). The cylindrical manubrium of the androphores (fig. 17, *hm*) is very large, purple, prominent from the narrow ostium of the umbrella, and contains a simple axial canal or central spadix.

Genus 45. *Anthemodes*,[1] Haeckel, 1869.

Anthemodes, Hkl., Ueber Arbeitstheilung, &c., **38**, p. 140.

Definition.—Agalmidæ with a long and movable siphosome, the trunk of which is very contractile; bracts with large intervals. Cormidia ordinate, with free internodes; palpons and gonostyles on the nodes. Tentilla with a simple terminal filament.

The genus *Anthemodes* was founded by me in 1869 for two different Atlantic Agalmids which I had observed in the winter of 1866–67 during my residence in the Canary Islands. One of these, figured as *Anthemodes canariensis* (**38**, Taf. i.) has loose cormidia and belongs to *Cupulita* (Genus 47*b*). The second species, described here as *Anthemodes ordinata*, and figured in Pls. XIV. and XV., has ordinate cormidia, with free internodes, and may be retained as the true type of this genus. Fragments of a similar species, *Anthemodes articulata*, have been found in a bottle in the Challenger collection from the South Atlantic (Station 325); it seems to differ from the former mainly in the thin foliaceous shape of the triangular bracts and the broader form of the nectophores. The cormidia in *Anthemodes* are as regularly ordinate as in *Stephanomia*, from which it differs mainly in the prolonged and very movable stem of the contractile (not rigid) siphosome.

Anthemodes ordinata, n. sp. (Pls. XIV., XV.).

Habitat.—North Atlantic, Canary Islands (Lanzerote), January 25, 1867 (Haeckel).

Nectosome (Pl. XIV. figs. 1–4).—The swimming apparatus was composed in the only specimen observed of a small pyriform pneumatophore at the top of the tubular trunk, and of eight nectophores disposed alternately in two opposite rows. Between the uppermost nectophore and the base of the pneumatophore were visible a few buds of young and undeveloped nectophores. Fig. 1 exhibits the nectosome from the lateral and fig. 2 from the dorsal side. The swimming movements of this most elegant Agalmid are very rapid.

Pneumatophore.—The float filled with air at the apex of the trunk is very small, pyriform; its pointed apex bears an octoradiate pigment-spot, composed of red-brown

[1] *Anthemodes* = Flower-shaped, *ἀνθεμώδης*.

polygonal cells. The dilated basal part presents eight longitudinal stripes, the external insertions of the eight radial septa which divide the pericystic cavity of the pneumatophore into eight radial pouches.

Nectophores (figs. 1, 4, lateral view; figs. 2, 3, dorsal view).—The nectocalyces are broad and short, truncate, conical in the tapering distal or basal part, provided with a pair of large auricles in the dilated apical or proximal part. The frontal axis of the latter is three times as long as that of the former, and twice as great as the principal and the sagittal axis. The principal axis is directed obliquely from above and within downwards and outwards. The upper or dorsal face is emarginate convex; the lower or ventral face concave, with a median groove, from which arises the short triangular pedicle attaching the nectophore to the trunk. The two lateral auricles or apical wings are nearly square, slightly bilobate on the lateral edge, and embrace the trunk in the middle interval between two nectophores of the opposite series (an upper and a lower). Each of the two paired wings is nearly as large as the odd basal part of the nectophore.

Nectosac (figs. 1–4).—The subumbrella of the nectophores has nearly the same form as the surrounding exumbrella, from which it is separated by a rather thin but firm jelly-plate. The two lateral auricles, however, are more deeply emarginate in the former, nearly bilobate. The four radial canals are, as usual, of very different size and form; the two sagittal simply curved in the sagittal plane (the dorsal about twice as long as the ventral); whilst the two lateral vessels (right and left) are much longer, and exhibit a complicated undulating course (with four loops), which is intelligible by comparison of figs. 3 and 4 (compare above, p. 216).

Siphosome (fig. 1).—The axial trunk of the siphosome is a slender and exceedingly contractile cylindrical tube, many times longer than the trunk of the nectosome. It has in the fully expanded state a length of 200 mm. or more, and is therefore ten times as long as in the strongly contracted state, when it is only 20 mm. long. The corm contracts very suddenly, and passes over rapidly from the former into the latter state. The entire trunk is densely covered with innumerable prismatic bracts, and at regular large intervals with a great number of ordinate cormidia. All the parts of the corm are so hyaline and transparent, and for the most part so glassy and colourless, that the animal is difficult to perceive, even in the fully expanded state and in motion. The swimming power of the nectosome is great and the usual locomotion very quick.

Cormidia (Pl. XIV. fig. 1; Pl. XV. fig. 5).—Each cormidium is composed of a large siphon (*s*), with a tentacle (*t*), a peculiar cyston (*y*), a male gonostyle (*h*), and a female (*f*), and a number of bracts, which compose a protecting cavity for the former parts. Besides, numerous other bracts cover the long internodes between the cormidia, which bear no other organs.

Bracts (Pl. XIV. fig. 1; Pl. XV. figs. 5, *b*, 6, *b*, 10).—The hydrophyllia are extremely numerous and of a peculiar form, difficult to perceive because of their glassy transparency,

and subject to many variations. The majority of the bracts have the form of a flat obelisk, or an irregular truncated four-sided pyramid, sometimes more approaching to a regular four-sided prism, at other times to an irregular spheroid. There are intermingled, too, three-sided and five-sided (or even six-sided) truncate pyramids between the prevailing four-sided ones. The four trapezoidal lateral faces are usually of nearly equal size; the lower or basal terminal face is more or less concave, and about twice as large as the upper or apical face. The edges are slightly convex and armed with a series of cnidocysts, a larger one being prominent from each angle (fig. 10). A single blind bracteal canal (figs. 5 and 6, *cb*) arises from that corner of the basal face which is attached by a short mobile pedicle to the trunk. The canal runs along the middle line of the concave basal face to about its centre, and ends there in a club-shaped blind dilatation.

Siphons (figs. 5, *s*, 6, *s*, 7).—The single polypite of each cormidium is relatively large, very contractile, transparent and colourless, and attached to the trunk by a short pedicle (*sp*). The entire surface of the siphon is covered with very long vibratile cilia, arising from the exoderm cells (fig. 7). The basigaster is rudimentary. The large stomach (*sm*) is spindle-shaped, and contains inside four longitudinal rows of prominent hepatic villi, each row composed of half a dozen conical villi (*sv*). Each villus seems to be a single very much enlarged, glandular entoderm cell, which contains besides the nucleus a large roundish hyaline vesicle, probably a digestive vacuole. Many stomachs were filled with the eaten tentilla of the animal itself. The proboscis (*sr*) is a long cylindrical tube with a very thick and mobile muscle-wall. It opens at the distal end by a very expansile mouth, the edge of which is armed with thread-cells (fig. 7, *so*). The mouth may be expanded and attached in the form of a circular or polygonal suctorial disc (fig. 5, *ss*); this becomes sometimes as large as the entire cormidium.

Tentacles (Pl. XV. figs. 5, *t*, 6, *t*, 7, *t*, 11–13).—The single tentacle, which is attached to the base of each siphon, is very long and bears a series of very numerous tentilla. Each tentillum is composed of a long pedicle (fig. 11, *ts*), an ovate cnidosac (*k*), and a thin simple terminal filament (*tf*). The pedicle is beset with numerous papillate villi (fig. 11, *tv*). The proximal half of the cnidosac is enclosed by a campanulate and ciliate involucre, whilst its distal half is free and beset with numerous, very large, radially distant cnidocils. The proximal base of the cnidosac contains a vesicular diverticulum of the canal, the middle part a horizontal turning of the spiral cnidoband, beset on both sides with a series of very large ensiform cnidocysts (*kg*) and above it a red pigment-spot; the distal end of the cnidosac is filled by globular cnidocysts. Whilst fig. 11 in Pl. XV. exhibits the fully-developed tentillum, two immature stages of its development are represented in figs. 12 and 13.

Cystons (figs. 5, *y*, 8, 9).—The single cyston, which is attached in each cormidium near to the base of the siphon, is about half as large as the latter. It consists of three parts: a short and small pedicle (*yp*), a large spherical thin-walled bladder, covered with

an elegant epithelium of large hexagonal cells (fig. 8, *y*), and a distal proboscis. This latter is spindle-shaped, covered outside and inside with long cilia, and has in the middle a spherical glandular dilatation, which contains a group of six to eight spherical (crystalline ?) concretions; they are black in transmitted light, white in reflected light. The pointed distal end of the cyston (figs. 5, 8, *yo*) can be widely opened (fig. 9, *yo*) and the excreta ejected through this anal opening.

Gonodendra.—Each cormidium is monoclinic, and bears at its base two small clustered gonodendra, a male (fig. 5, *h*) and a female (fig. 5, *f*). The gonostyles are in both sexes little branched, and the gonophores attached by simple pedicles; their umbrella is little developed or rudimentary. Each gynophore (figs. 5, *f*, 15) encloses only a single, large, subspherical ovum, surrounded by a network of spadicine canals (fig. 15, *xm*). The manubrium of the androphores (figs. 5, *h*, 14) is large, club-shaped, and contains a simple axial canal or central spadix (fig. 14, *hc*).

Genus 46. *Cuneolaria*, Eysenhardt,[1] 1821.

Cuneolaria, Eysenhardt, **16**, Nova Acta Acad. Nat.-Curios., t. x. pars 2, p. 369.

Definition.—Agalmidæ with a long and movable siphosome, the trunk of which is very contractile; bracts with large intervals. Cormidia ordinate, with free internodes; palpons and gonostyles on the nodes. Tentilla tricornuate, with a terminal ampulla and two paired horns.

The genus *Cuneolaria* was established in 1821 by Eysenhardt (**16**, p. 369) for an Agalmid from the Northern Pacific, near the Sandwich Islands, of which he had observed (in September 1817) only the detached nectophores (fig. 5, *a*), bracts (fig. 5, *bc*), and tentacles (fig. 5, *d*, *e*, *f*). These seem to be identical with some fragments of an Agalmid which was captured by the Challenger in the same region in September 1875 (Station 269). The form of the nectophores, bracts, and tentacles agrees perfectly with the figures of Eysenhardt. A fragment of the siphosome exhibited four ordinate cormidia, separated by free internodes, of the same composition as in *Anthemodes* (Pl. XV.). *Cuneolaria* differs, however, from this latter in the form of the tentilla, which are tricornuate, as in *Crystallodes* (Pl. XVII.). *Stephanomia heptacantha*, captured by Quoy and Gaimard near the Molucca Islands (**2**, pl. iii. figs. 16–18), is perhaps identical with that species. *Stephanomia imbricata* of the same authors, from New Zealand (**2**, pl. iii. figs. 13–15), may be another species of the same genus. The figures and descriptions of the French authors are, however, too incomplete to determine with any certainty the true anatomical composition and systematic position of these Agalmids. *Cuneolaria* exhibits the same relation to *Anthemodes* that *Crystallodes* bears to *Stephanomia*.

[1] *Cuneolaria* = Animal with wedge-shaped pieces, *cuneolus*.

Genus 47*a*. *Halistemma*,[1] Huxley, 1859.

Halistemma, Huxley, Oceanic Hydrozoa, pp. 70, 129.

Definition.—Agalmidæ with a long and movable siphosome, the trunk of which is very contractile; bracts with large intervals. Cormidia loose; palpons and gonostyles on the internodes scattered between the siphons. Tentilla with a naked cnidoband and a simple terminal filament.

The genus *Halistemma* was established by Huxley in 1859 for that Mediterranean Agalmid, the first description of which Vogt had published under the name *Agalma rubrum* (**6**, Tab. vii.–xi.). Perhaps identical with this species (from Nice) is another Mediterranean form, which Kölliker has figured under the name *Agalmopsis punctata* (**4**, Tab. iv.). Succeeding observers have described many different Agalmidæ as *Halistemma*, and mainly those forms which belong to the following genus *Cupulita*. But the true *Halistemma*, according to the definition given by Huxley, differs from all allied Agalmidæ in the simple structure of the tentilla, which have the same form as in *Forskalia* (Pl. IX. fig. 7, *t*; Pl. X. fig. 23). The naked cnidoband is a simple spirally convoluted riband without involucre, and bears a simple terminal filament. In all other respects *Halistemma* seems to agree with *Cupulita*; but perhaps both genera differ also in the structure of the palpons, which in the former seem to be mouthless, in the latter provided with a terminal mouth (cyston).

Genus 47*b*. *Cupulita*,[2] Quoy and Gaimard, 1824.

Cupulita, Quoy et Gaimard, Voyage de l'Uranie, &c., p. 580.

Definition.—Agalmidæ with a long and movable siphosome, the trunk of which is very contractile; bracts with large intervals. Cormidia loose; palpons and gonostyles on the internodes scattered between the siphons. Tentilla with an involucrate cnidoband and a simple terminal filament.

The genus *Cupulita* was founded in 1824 by Quoy and Gaimard for an Agalmid, which Gaudichaud had captured at Port Jackson. The description of their *Cupulita bowdichii* (**19**, pl. lxxxvii. figs. 14–16) is very incomplete; but the figure which they give of the nectosome is so similar to that of *Halistemma tergestinum* and some closely allied species, that we employ the older name for these latter, instead of giving a new name. *Cupulitá* is in all respects very similar to the true *Halistemma* (*rubrum* or *punctatum*), but differs in the form of the tentilla; the spiral cnidoband is not naked (as in the latter), but enveloped by a campanulate involucre. Another difference is perhaps marked by the structure of the palpons, which in *Cupulita* are true excretory

[1] *Halistemma* = Marine corona, ἅλιος, στέμμα.

[2] *Cupulita* = Beset with cupules.

cystons (with a terminal mouth), whilst they seem to be mouthless in *Halistemma*. Besides the oldest known form, the Australian *Cupulita bowdichii*, the following species probably belong to this genus:—(1) *Nanomia carą*, A. Ag. (North-west Atlantic, **37**, p. 200); (2) *Anthemodes canariensis*, Haeckel (North-east Atlantic, **38**, p. 140, Taf. i.); (3) *Agalmopsis fragilis*, Fewkes (Tropical Atlantic, **44**, pl. v. fig. 2); (4) *Agalmopsis elegans*, Sars, *partim!* (North Atlantic, **27**, Heft i. Taf. v.); (5) *Halistemma pictum*, Metschnikoff, described in 1871 in the Russian language, Mediterranean); (6) *Halistemma tergestinum*, Claus (Adria, **74**, Taf. i.–v.).

Genus 48. *Agalmopsis*,[1] Sars, 1846.

Agalmopsis, Sars, Fauna littoralis Norvegiæ, Heft i. p. 31, taf. v., vi.

Definition.—Agalmidæ with a long and movable siphosome, the trunk of which is very contractile; bracts with large intervals. Cormidia loose; palpons and gonostyles on the internodes scattered between the siphons. Tentilla tricornuate, with a terminal ampulla and two paired horns.

The genus *Agalmopsis* was described very accurately by Sars in 1846, and illustrated by excellent figures. The North Atlantic Agalmidæ, however, which are represented in his pls. v. and vi., belong to two (or even three?) different genera. The first form, figured in pl. v., has simple terminal filaments of the tentilla, and belongs therefore to the preceding genus *Cupulita*. The second form, represented in pl. vi., has tricornuate tentilla, with an odd terminal vesicle and two paired lateral horns. This form may retain the original name *Agalmopsis elegans*, and represent the type of this genus. Closely allied to it is the North American *Agalmopsis catena*, described by Fewkes as *Agalma elegans* (**43**, viii. pls. ix., x.). A different species, *Agalmopsis dissoluta*, Hkl., inhabits the Tropical Atlantic. A fourth species is the Mediterranean *Agalmopsis sarsii*, accurately described by Kölliker (**4**, p. 10, Tab. iii.).

Genus 49. *Lychnagalma*,[2] Haeckel, 1881.

Lychnagalma, Hkl., MS. Ind., and System der Siphonophoren, p. 40.

Definition.—Agalmidæ with a long and movable siphosome, the trunk of which is very contractile; bracts with large intervals. Cormidia loose; palpons and gonostyles on the internodes scattered between the siphons. Tentilla multicornuate, with a terminal ampulla and a corona of eight radial horns.

The genus *Lychnagalma* was established by me for a most elegant small Agalmid, a complete specimen of which I had captured in December 1881, during my residence in

[1] *Agalmopsis* = Similar to an Agalma; ἄγαλμα, ὄψις. [2] *Lychnagalma* = Candelabra ornament, λύχνος, ἄγαλμα.

Ceylon. It is represented in Pl. XVI. A similar species was described in 1879 by Claus from the Mediterranean, as *Agalmopsis utricularia* (**75**, p. 199, Taf. xviii.). Fewkes proposed for it in 1883 the generic name *Calliagalma* (**42**, xviii. p. 844); but this name has been previously employed for an Insect. The peculiar and very remarkable form of the tentilla distinguishes this interesting genus not only from the closely allied *Agalmopsis*, but also from all other Agalmidæ. Each tentillum bears a large terminal ampulla, which is surrounded by an elegant corona of eight radial filaments. The ampulla is a hydrostatic apparatus, lighter than the sea water, and directed upwards, whilst the surrounding filaments are either horizontally expanded or move in different directions. They form an extended net around the corm, well fitted for capturing prey.

Lychnagalma vesicularia, n. sp. (Pl. XVI.).

Habitat.—Indian Ocean, Ceylon (Belligemma), December 1881 (Haeckel).

Nectosome.—The swimming apparatus is similar to that of *Cupulita* and *Agalmopsis*, composed of a small apical pneumatophore (figs. 1, 2, *p*, 4) and two opposite series of about sixteen alternating nectophores (figs. 1, *n*, 5, 6).

Pneumatophore.—The float is ovate, with an octoradial red-brown pigment-star on the apex, and eight equidistant longitudinal ribs in the basal half. These are the insertions of the eight vertical septa which divide the cavity of the pneumatophore into eight radial pouches (fig. 4, *pq*). A horizontal annular septum, similar to a diaphragm, divides the pneumatosac, somewhat beyond its equator, into two unequal halves; the superior larger half contains the chitinous pneumatocyst; the inferior smaller half is lined by a greenish, air-secreting epithelium, the pneumadenia; both halves communicate by a circular opening in the diaphragm, the pneumatopyle.

Nectophores (figs. 5, 6).—The swimming-bells are very similar to those of *Cupulita canariensis*, rather square in the frontal view (fig. 6), irregularly pentagonal in the lateral view (fig. 5). The convex dorsal face has a median rounded ridge, which fits into a corresponding groove on the concave ventral face of the superjacent nectophore. From the apical part of the latter arises a short triangular pedicle which attaches the bell to the axial trunk. The two paired lateral facettes (on both sides of the median groove) are produced into two apical horns, or nearly triangular-pyramidal auricles. The distal base of the nectophore is obliquely truncate. The large nectosac is correspondingly tripartite hammer-shaped, with an odd median basal or distal part, and two paired ovate lateral pouches. Its four radial canals exhibit the usual shape, the two sagittal vessels run simply curved in the median plane of the subumbrella, whilst the two lateral vessels (figs. 5, 6, *cl*) are much longer and form several loops.

Siphosome (fig. 1).—The axial trunk of the siphosome is in the expanded state four

to six times as long as in the contracted state, and as the trunk of the nectosome. It bears twelve to sixteen siphons, and between them very numerous palpons and gonophores scattered along the trunk. The cormidia are, therefore, loose. The entire siphosome is densely covered by innumerable bracts, similar to *Cupulita* and *Agalmopsis*.

Bracts (figs. 7, 8).—The hydrophyllia are rather flat and broad scales, ovate or triangular in outline, with a convex dorsal and a concave ventral side. Near the latter a blind bracteal canal (*bc*) runs in the middle line. The proximal end is tapering, and attached by a short pedicle to the trunk. The broadened distal end is provided with three to five short triangular teeth (figs. 1, 3, *b*).

Siphons (fig. 3, *s*).—The polypites are large, and very movable, provided with a long pedicle. The ovate basigaster is narrow. The spindle-shaped stomach exhibits eight hepatic ridges. The cylindrical proboscis opens by a mouth which may be expanded in the form of a large and thin polygonal suctorial disc (fig. 3, *ss*).

Tentacles.—The long tentacle which is attached to the base of each siphon, in the constriction between pedicle and basigaster, bears a series of numerous tentilla. The thin pedicles of the tentilla are directed vertically upwards (fig. 1). The cnidosac contains a long purple cnidoband coiled up spirally (fig. 9, *tk*), and enclosed by an ovate involucre (*th*); the spiral turnings (six to eight) are in the proximal part horizontal, in the middle part oblique, and in the distal part nearly vertical. The terminal ampulla (fig. 9, *ta*) is ovate, larger than the cnidosac, and encloses in its distal apex an oil-globule, acting like a hydrostatic float. The base of the ampulla is surrounded by a corona of eight slender and very movable radially divergent filaments (fig. 9, *tc*).

Palpons.—The entire trunk of the siphosome is covered with scattered palpons, about six to eight between every two siphons. They are slender, spindle-shaped, and very movable tubes, the distal apex of which is armed with cnidocysts. Each palpon (fig. 3, *q*) bears on its base a long and very thin palpacle, or a simple tasting filament (*r*).

Gonodendra.—The corm is monœcious, and the cormidia monoclinic. Numerous male and female gonodendra are scattered along the trunk, about half a dozen between every two siphons, two males and four females. The gonophores are larger and less numerous in the male gonodendra (fig. 3, *h*) than in the females (*f*). Their structure, which I could not sufficiently examine, seems not to differ from that of other Agalmidæ.

Family XIV. Forskalidæ, Haeckel, 1888.

Forskalidæ, Hkl., System der Siphonophoren, p. 42.

Definition.—Physonectæ polygastricæ, with a long tubular stem of the siphosome, bearing numerous siphons, palpons, and bracts, each siphon provided with a branched tentacle. Nectosome multiserial, strobiliform, with several spiral rows of nectophores. Pneumatophore with radial pouches.

The family Forskalidæ comprises those Physonectæ polygastricæ which have a long tubular stem of the siphosome densely covered with bracts, and a strobiliform nectosome composed of numerous spiral rows of nectophores. The siphons are very large, and distinguished by a very long pedicle. They differ in these characters from most other Physonectæ, the nectosome of which is either biserial or quadriserial. The corona of bracts of the Anthophysidæ, however, may be compared with the spiral nectosome.

Although the Forskalidæ are the largest and the most splendid of all Physonectæ, and some species occur in the Mediterranean and the Atlantic in large numbers, nevertheless they remained perfectly unknown up to the year 1841. In that year Milne-Edwards published the first description of two Mediterranean species, under the names *Stephanomia contorta* and *Stephanomia prolifera* (**71**, p. 217, pls. vii.–ix.). It was completed twelve years afterwards by Kölliker, who established for them the genus *Forskalia* (**4**, p. 2, Tafs. i., ii.). Additions were afterwards made by Leuckart (**8**), Vogt (**5**), Keferstein and Ehlers (**33**), and Claus (**35**). Recently (1881) an Atlantic species of *Forskalia* has been described by Fewkes, under the name *Stephanomia atlantica* (**44**, p. 264, pls. v., vi.). Another Atlantic species, *Forskalia tholoides*, was observed by me in 1866 off the Canary Islands, and is described in the following pages (Pls. VIII.–X.).

A very remarkable and gigantic deep-sea Physonect, which probably belongs to this family, was described in 1878 by Studer (**40**) under the name *Bathyphysa abyssorum*, and in 1884 by Fewkes (**45**) as *Pterophysa grandis*. A similar form, of which I was able to examine some fragments, makes it probable that these giants of the deep sea do not belong to the Rhizophysidæ (as the last-named author supposes) but to the Forskalidæ. Another new and interesting genus of this family, described in the following pages as *Strobalia*, was observed by me in 1881 in the Indian Ocean, and illustrates the affinities of this peculiar family.

Nectosome.—The swimming apparatus in the Forskalidæ is larger, stronger, and more highly developed than in any other Physonectæ. The pneumatophore at the apex of the trunk is small, but the nectophores are very numerous (usually more than one hundred) and arranged in a continuous spiral. The whole nectosome is sometimes cylindrical or conical, at other times more campanulate or hemispherical; its different forms are comparable to those of the different cones of firs. Its rounded surface is elegantly panelled or facetted by the basal ostia of the nectophores, which are regularly disposed in a quincuncial manner. The spiral line which connects the basal insertions of the nectophores has four to eight or more turnings, and is usually læotropic, therefore opposite to the dexiotropic spiral of the siphosome. The genus *Forskaliopsis* is distinguished by the possession of palpons which are scattered between the nectophores. The physiological activity of the nectosome is more highly developed than in all the other Physonectæ, since the great number of nectophores and their pointing in all directions enables the animal to perform a greater variety of swimming motions.

Pneumatophore.—The float at the top of the trunk is relatively small, usually ovate or pyriform, and pigmented in the apical part. Its outer wall (pneumatocodon) is connected with the inner wall (pneumatosaccus) by a variable number of vertical radial septa: four in *Strobalia*, six to eight or twelve in *Forskalia* and *Forskaliopsis*, sixteen in *Bathyphysa*. The radial pouches or chambers of the pericystic cavity, which are separated by these septa, are closed above, but open below in the common trunk, beyond the funnel-cavity of the pneumatosac.

Nectophores.—The numerous nectocalyces, owing to their multiserial and spiral arrangement on the nectosome, differ in form considerably from those of the other Physonectæ. Usually they are attached to the common trunk by a long pedicle of conical or pyramidal form. Their umbrella is prismatic, with polygonal faces, produced by the mutual pressure of the densely associated nectophores. The subumbrella is more or less compressed in the sagittal direction, dilated laterally, often provided with two lateral horns. Sometimes the exumbrella of the apical part, corresponding to the latter, bears two prominent apophyses. The four radial canals of the nectosac, according to that dorso-ventral compression, are usually of different sizes, the two lateral longer than the two sagittal vessels. The ring-canal which connects them at the constricted ostium of the nectosac is sometimes circular, at other times elliptical. Often some ocelli, red or brown pigment-spots, are visible above the small velum, at the inosculation of the radial canals. From the proximal union of the latter in the top of the nectosac arises a long peduncular canal which runs through the pedicle of the nectophore and opens into the axial canal of the trunk (Pl. VIII. figs. 2, 3).

Siphosome.—Corresponding to the high development of the nectosome in the Forskalidæ, this interesting family surpasses all the other Physonectæ also in the complicated composition and extraordinary size of the siphosome; it attains in the largest species a diameter of more than one metre in the fully expanded state; in *Bathyphysa* probably four to six metres or more; in the strongly contracted state it is much smaller. The numerous siphons are attached to the long trunk of the siphosome by very long peduncles, and these, as well as the trunk itself, are densely covered with innumerable bracts. These envelop, densely crowded, the outer surface of the contracted siphosome like a protecting carapace of scales. The entire form of the siphosome is sometimes more cylindrical or inversely conical, at other times more ovate or hemispherical; fully expanded, with widely prominent and brilliantly coloured appendages, it presents a most splendid spectacle.

Cormidia.—The number of the cormidia which compose the siphosome is usually very large, thirty to fifty or more, in the larger species several hundreds (sometimes more than five hundred). They are arranged around the axial trunk in a continuous spiral, the turning of which is usually right-handed (or dexiotropic), in contrast to the left-handed (or læotropic) spiral of the nectosome. The trunk itself is correspondingly

more or less spirally convoluted; it is sometimes regularly articulate, with equidistant segmental constrictions (in *Strobalia* and *Forskalia*, Pl. IX. fig. 7, *a*); at other times the annular constrictions disappear and the cylindrical or slightly compressed stem is not articulate (in *Forskaliopsis* and *Bathyphysa*). Respecting the composition of the cormidia and their attachment at the trunk, we distinguish in the Forskalidæ ordinate and loose cormidia; the former occur in *Strobalia*, the latter in the three other genera.

The ordinate cormidia of *Strobalia* are similar to those of *Stephanomia*, *Crystallodes*, *Anthemodes*, &c. Each cormidium is attached to a node of the trunk, or a constriction of the stem, and composed of five different medusomes, three sterile (a siphonal, a cystonal, and a palponal) and two fertile (a male and a female). The siphonal medusome is composed of a pedunculate siphon, a tentacle, and a corona of bracts on the base of the pedicle. The cystonal medusome consists of a cyston and a palpacle, surrounded by a group of bracts. The palponal medusome is composed of a palpon with its palpacle and a basal corona of bracts. The two sexual medusomes are represented by a pair of gonodendra, which bear clustered gonophores, a male and a female. The long internodes of the stem, between these ordinate distylic cormidia, are free and covered only by small bracts.

The loose cormidia of the other three genera of Forskalidæ may be derived from the ordinate cormidia of *Strobalia* by dislocation of the associated medusomes. The axial trunk of the siphosome preserves in *Forskalia* the distinct articulation, whilst this is lost in *Forskaliopsis* and *Bathyphysa*. The polymorphous medusomes which compose the cormidia are here more or less separated, and the different persons and their organs more or less scattered. In *Forskalia* sometimes each cormidium is composed rather regularly of four separate and different medusomes, attached at intervals to the succeeding internodes of the stem. The first medusome is a siphonal one (with siphon and tentacle), the second a cystonal (with cyston and palpacle), the third a palponal (with palpon and palpacle), and the fourth a sexual (with a sexual palpon and a monostylic gonodendron). But in the larger corms of *Forskaliopsis* and of *Bathyphysa* the number and succession of medusomes in each cormidium seems to be variable and often perfectly irregular.

Bracts.—The hydrophyllia or covering scales are always very numerous, and cover, densely crowded, not only the stem of the siphosome, but also the long pedicles of the single siphons, cystons, and palpons. Their number is even in the smaller species several hundreds, and in the larger many thousands. The splendid Mediterranean *Forskaliopsis ophiura* has more than five hundred siphons and on the pedicle of each siphon more than a hundred bracts; the number of cystons and palpons, however, amounts to two thousand to four thousand or more; and since the pedicles of these are also covered with bracts, the total number of the latter may amount to more than

a hundred thousand. The form and size of the bracts are extremely variable and usually more or less irregular; their arrangement is very difficult to recognise, since they are hyaline and easily detached. Usually they have the form of oblongish scales, with concave lower and convex upper face; the latter bears often three to five dentate ribs or crests. The bracteal canal is always simple and runs along the lower face. The great variety in size and form of bracts, in one and the same specimen, is exhibited by figs. 10 to 18 of Pl. X.

Siphons.—The polypites of the Forskalidæ are very large and highly developed, and sometimes of an extraordinary size. The spindle-shaped siphons of *Bathyphysa* are larger than those of any other Siphonophoræ hitherto known; they attain (in a strongly contracted state) the length of 50 to 60 mm. and the thickness of 30 mm., and are attached by pedicles of 200 mm. in length. But even in the smaller species of this family the siphons and their pedicles attain a considerable size. The thin tubular pedicles are usually covered with numerous bracts, in manner similar to the trunk of the siphosome. The three parts of the siphon proper are usually well developed (Pl. IX. figs. 7–9). The thick-walled basigaster, with masses of cnidocysts, is sometimes divided by four longitudinal furrows into four equal quadrants. The wide stomach bears usually eight, twelve, or sixteen longitudinal liver-ridges, coloured brown or red; these are wanting in *Bathyphysa*, being replaced by innumerable small hepatic villi (similar to those of *Athorybia*). The muscular proboscis is very strong and extensible, and provided with a widely expansible mouth. The opening of the mouth is often surrounded by a corona of eight or sixteen short lobes.

Tentacles.—The form and structure of the single large tentacle which is attached to the base of each siphon seems to be the same in all Forskalidæ. The point of insertion is in the constriction between the basigaster and the distal end of the long pedicle (Pl. IX. figs. 7, 8). The number of equidistant tentilla or lateral branches, which are inserted in the nodes of the regularly segmented tentacle, is very large. Each tentillum (Pl. X. fig. 23) has a long pedicle (*ts*), a large spiral cnidoband (*tk*), and a long terminal filament (*tf*). The number of the spiral turnings of the naked cnidoband, which is not enclosed by an involucre, is variable in the single species, usually two, three, or four. Its colour corresponds to that of the siphon (usually red). The broad spiral riband is composed of many series of innumerable small paliform cnidocysts, and of two simple lateral series of large ensiform cnidocysts (fig. 23, *tk*).

Cystons.—All Forskalidæ possess a great number of hydrocysts or spindle-shaped vesicles, which are attached to the base of the siphons in *Strobalia*, whilst they are inserted into the trunk of the siphosome, between the siphons, in the three other genera. They are usually described as "tasters." An accurate examination of them, however, shows that three different forms of them must be distinguished, viz., cystons, palpons, and gonopalpons. The two former bear a palpacle, wanting in the latter. The cystons,

anal or excretory vesicles (Pl. X. fig. 19), differ from the two other forms in the possession of a terminal opening. They are much smaller than the siphons, and without hepatic ridges, but exhibit a similar composition of four different segments; a basal pedicle (fig. 19, *qp*), a thick-walled hemispherical basigaster, at the base of which is inserted the single long palpacle (*r*), a large thin-walled stomach (*q*), and finally a conical or pyriform chromadenia, with a distal opening. This latter segment, which is comparable to the proboscis of the siphons, is most characteristic of the cystons; it is a colour-gland, which produces a great mass of pigment-granules, and extrudes it through the terminal anus. The dark glandular entoderm of the chromadenia is much thicker than the colourless entoderm of the thin-walled stomach; the pigment-granules secreted by it are usually red or brown, sometimes intermingled with small crystals. When a quietly floating *Forskalia* is touched, it suddenly discharges the contents of the chromadenia, and makes the surrounding water dark and intransparent. Kölliker (**4**, p. 8) and Leuckart (**5**, p. 17, and **8**, p. 348) have already described this interesting excretion; but they suppose that there is no true opening at the distal end of the cystons, and that the pigment is discharged by rupture of their wall. Repeated observations on the living *Forskalia tholoides* have convinced me that the pyriform red chromadenia, or the opaque distal portion of the cyston, possesses a constant terminal opening. This anus or excretory opening, however, is difficult to observe in the closed state (as is also the case in the mouth and the anus of many lower animals). The opening has been observed too by Studer in the cystons of *Bathyphysa abyssorum*, which he has described as bracts (**40**, p. 20). The excretion of the pigment-masses and the darkening of the water by it have probably the same physiological function as in the Cephalopoda;—to protect the attacked animal from its persecutors, and facilitate the capture of food-animals.

Palpons.—Whilst one cyston only belongs to each cormidium of probably all Forskalidæ, the number of true palpons (formerly confounded with the cystons) is usually much larger. In *Forskalia* there belong usually two palpons (arising from a common pedicle) to each cormidium, in *Forskaliopsis* three, four, or more; in some of the largest forms a pediculate bunch of four to six or more palpons arises from the trunk between each siphon and the appertaining cyston. The true palpons differ from the latter mainly in the absence of a distal opening; they are closed at the pointed distal end, and communicate only by the pedicle with the tube of the trunk. Their size is usually about half that of the siphons and cystons, but very variable according to the different state of contraction. Sometimes the palpons are simple pyriform or spindle-shaped vesicles, at other times divided by an annular constriction into a smaller proximal and a larger distal part. The pointed apex of the latter is usually provided richly with larger cnidocysts and long sensitive cnidocils, sometimes also coloured by pigment. Their function is sensory. The long palpacle which arises from

the base of each palpon is always a simple thin tasting filament, richly provided with small cnidocysts and cynidocils.

Gonodendra.—The corms of all Forskalidæ seem to be monœcious; the cormidia are usually monoclinic; but in *Bathyphysa* perhaps diclinic. The gonodendra are distylic, either male or female, in *Bathyphysa* and *Strobalia*, whilst they are monostylic in *Forskalia* and *Forskaliopsis*. Each cormidium usually possesses in these two typical genera a single pediculate gonodendron, which arises separately from the siphon and cyston, and bears upon a common pedicle a spindle-shaped sexual palpon (Pl. X. fig. 21) and numerous roundish gynophores in the proximal part, oblongish androphores in the distal part. Each female gonophore (*f*) develops only a single large ovum, each male a large club-shaped spermarium (*h*). In some species two sexual palpons ("twin-tasters"), more rarely three or four, are attached to the base of the hermaphroditic gonodendron. There seems to be some variety in this arrangement. *Strobalia* differs in the possession of two separate clustered gonodendra, a male and a female, both arising separately from the common base of the ordinate cormidium.

Synopsis of the Genera of Forskalidæ.

Nectosome without palpons. Trunk of the siphosome articulate, with regular equidistant annular constrictions.	Cormidia ordinate. Gonodendra distylic, arising from the base of the siphonal pedicles,	50. *Strobalia.*
	Cormidia loose. Gonodendra monostylic, alternating with the siphonal pedicles,	51. *Forskalia.*
Nectosome with palpons between the nectophores. Trunk of the siphosome not articulate, without regular annular constrictions.	Cormidia loose. Gonodendra monostylic, between the siphons, which have hepatic ridges (no villi),	52. *Forskaliopsis.*
	Cormidia loose. Gonodendra distylic, between the siphons, which have hepatic villi (no ridges),	53. *Bathyphysa.*

Genus 50. *Strobalia*,[1] Haeckel, 1888.

Strobalia, Hkl., System der Siphonophoren, p. 42.

Definition.—Forskalidæ with ordinate cormidia, and segmented trunk of the siphosome. Gonodendra distylic, arising from the base of the siphonal pedicles. Siphons with hepatic ridges. Nectosome without palpons.

The genus *Strobalia* comprises some new species of Forskalidæ, which are very similar in general appearance to some smaller forms of the true *Forskalia*, but differ from it in two important points. The cormidia are perfectly ordinate, not loose; and the gonodendra are gonochoristic or distylic. Each cormidium of the siphosome is composed of five different medusomes, three of which are sterile (a siphonal, a cystonal, and a palponal) and two fertile (a male and a female). Each of the three sterile

[1] *Strobalia* = Marine spiral, στρόβος, ἅλιος.

medusomes is again composed of three corresponding organs, viz., a manubrium (a siphon, a cyston, or a palpon), an appertaining filament (tentacle or palpacle), and a corona of bracts (corresponding to the umbrella of the original medusa). The two sexual medusomes, or rather clusters of medusomes, are represented by two gonochoristic bunches of gonodendra, a male and a female; they arise separately from the common base of the cormidium, from the basal insertion of the long pedicle of the polypites; the male bunch is smaller than the female. The form and structure of the single parts are essentially the same as in the closely allied *Forskalia;* but the internodes of the trunk, between the equidistant cormidia, are covered only with bracts. *Strobalia* therefore exhibits a similar relation to *Forskalia* as *Anthemodes* does to *Halistemma*, or *Crystallodes* to *Agalma*. A beautiful species of this genus, *Strobalia cupola*, was observed living by me in the Indian Ocean, and will be described in my Morphology of the Siphonophoræ; a fragment of a similar species, *Strobalia conifera*, was collected by the Challenger in the South Pacific (Station 288).

Genus 51. *Forskalia*,[1] Kölliker, 1853.

Forskalia, Kölliker, Die Schwimmpolypen von Messina, p. 2.

Definition.—Forskalidæ with loose cormidia and segmented trunk of the siphosome. Gonodendra monostylic, arising from the trunk, separate from the siphonal pedicles. Siphons with hepatic ridges. Nectosome without palpons.

The genus *Forskalia*, hitherto the only representative of this family, comprises in the definition here stated those forms, the well-known type of which is the Mediterranean *Forskalia contorta*, Leuckart (8), probably identical with *Forskalia edwardsii* of Kölliker (4). The trunk of the siphosome is in this species, as well as in *Forskalia tholoides* described in the sequel, distinctly segmented or articulate, with equidistant annular constrictions, from which the single medusomes of the loose cormidia take origin. Usually three different medusomes arise separately from the stem between every two siphons, viz., (1) a sterile cyston with a palpacle; (2) a sterile palpon with a palpacle; and (3) a sexual palpon, to the base of which is attached a clustered monostylic gonodendron (with female gonophores on the proximal part and male gonophores on the distal part). But sometimes the number of palpons is multiplied (often two or three arising from a common pedicle), and their arrangement is more irregular. Another difference between *Forskalia* and *Forskaliopsis* is seen in the presence of palpons in the nectosome of the latter, wanting in the former. The general appearance of *Forskalia* is more delicate and similar to *Strobalia* and to *Agalmopsis*. Probably to this genus belong a number of different species inhabiting the warmer seas, *e.g.*, *Stephanomia atlantica* of Fewkes (44); but their distinction requires a further accurate comparison.

[1] *Forskalia*, named in the honour of the celebrated naturalist, Petrus Forskål (1775).

Forskalia tholoides, n. sp. (Pls. VIII.–X.).

Forskalioma tholoides, Hkl., 1866, MS. Canar.

Habitat.—Lanzerote, Canary Islands, December 1866 (Haeckel).

Nectosome (Pl. VIII.; Pl. IX. fig. 6).—The swimming apparatus is very large, campanulate or cupola-shaped, and has a diameter of 35 to 40 mm. The axial trunk is a slender tubule, slightly curved and twisted spirally, of a reddish colour. Its apex bears a small pyriform pneumatophore. The nectophores are very numerous, and so densely aggregated that no intervals remain between them. They are arranged as regularly in a continuous spiral as the bracts in a fir-cone. In the lateral view of the nectosome of a middle-sized specimen (fig. 1) about sixteen to twenty longitudinal rows of nectophores may be distinguished, and nearly the same number of alternating transverse rows, so that their total number may amount to three hundred or four hundred, and in the larger specimens more.

Pneumatophore (figs. 1, 6, *p*).—The float is an ovate, relatively small vesicle, slightly prominent over the surrounding corona of nectophores at the top of the stem, and coloured pink in the upper or apical half. Its outer membrane, or the pneumatocodon, is connected with the inner membrane, or the pneumatosaccus, by eight vertical radial septa. These divide the cavity of the pneumatophore into eight radial pouches. Its structure is the same as figured by Claus in *Forskalia edwardsii*, which, however, has only six radial pouches (**35**, Taf. xlvii. fig. 16). The apex of the pneumatophore (Pl. X. fig. 24) has the form of an ocellus, a dark circular apical spot (similar to a closed opening), being surrounded by a clear colourless ring, and this again by a regular pink pigment-cross. The four rays of this cross are forked, and the eight fork-branches, composed of elegant pigment-cells, are divergent and equidistant towards the equator of the pneumatophore, corresponding to the abaxial insertion of the eight internal radial septa.

Nectophores (Pl. VIII. figs. 1–5).—The nectocalyces are irregularly prismatic, with polygonal lateral faces produced by mutual compression. They are attached to the axial trunk of the nectosome by long pyramidal pedicles (*np*). These are shorter in the superior, longer in the inferior nectophores, where they attain double the length of the umbrella. A long nectocalycine duct (*ns*) enters into the axial apex of the pyramidal pedicle and runs in its axis towards the top of the campanulate subumbrella. It divides here into four radial canals (*nr*), which are united above the small velum (*v*) by a ring-canal (*nc*). Figs. 2–5 exhibit four different stages in size in the development of the nectophores (fig. 5 a very young one).

Siphosome (Pl. VIII. fig. 1, inferior half, seen in profile; Pl. IX. fig. 6, apical view).—The siphonophorous part of the entire corm, or the siphosome, has a very

different appearance according to the state of contraction of the different persons composing it. In the strongly contracted state (fig. 6) it is nearly spherical, scarcely larger than the dome-shaped nectosome above it; in the highly expanded state it is three or four times as large, and presents a most elegant aspect. The numerous cormidia (forty to fifty in the figured specimen) are arranged around the central spirally-turned trunk in a large dexiotropic spiral (or Delta-spiral), whilst the spiral arrangement of the nectophores is an opposite one (læotropic or Lambda-spiral), similar to that of the cnidoband in the tentilla (Pl. X. fig. 23). The spiral axial trunk (fig. 7) is articulate, and its pink central canal (*ac*) runs near the concave dorsal side.

Cormidia (figs. 1, 6, 7).—The cormidia, which compose the siphosome, are arranged in this species in an irregular manner, and disposed in a different way from those of other nearly allied species. It may represent, therefore, a separate genus, *Forskalioma*. The trunk of the siphosome (Pl. IX. fig. 7, *a*), which is distinctly articulate, bears the series of cormidia on its convex ventral side, where they arise from equidistant nodes, or annular constrictions of the stem. Usually each loose cormidium is composed of four different medusomes, viz., (1) a long-stalked siphon, with its tentacle and numerous bracts; (2) a stalked cyston, with a palpacle and a group of bracts; (3) a stalked palpon, with a palpacle and a bunch of bracts; (4) a gonostyle with a sexual palpon and a monoclinic gonodendron. This kind of regular composition is probably the original one, and is characteristic of this species. It is, however, not quite constant, but subject to some individual variations, which may be partly accidental. A further accurate examination and comparison of the composition of the loose cormidia is particularly required in this as well as in all other Forskalidæ hitherto described.

Bracts (figs. 1, 7, *b*, 10–18).—The innumerable hydrophyllia which cover the entire siphosome are attached as well immediately to the trunk of it as to the pedicles of the siphons, and to the bases of the pediculate cystons and palpons. Their number amounts to more than a thousand in the largest specimens. The greatest number of these bracts are small or of medium size, and of simple form (figs. 10–13); some of them become larger and are developed in the form of large protective scales (figs. 7, *b*, 17, 18) covering the convex outside of the siphosome (fig. 1). These larger bracts are three-sided prismatic, more or less asymmetrical, with a concave smooth lower or distal face, and a convex dentate upper or proximal face. This latter bears usually a strong dentate longitudinal crest, and the two lateral edges are also armed with a few teeth. The smaller bracts have no crest and dentation; they seem to fill up the intervals between the larger, and are of very irregular form and different sizes (compare figs. 10–14). A blind longitudinal bracteal canal arises from the trunk and runs near the concave inferior face of the bract.

Siphons (figs. 1, 6, *s*, 7, *s*, 8, 9).—The polypites are large, 10 mm. to 15 mm. long, and

attached to the distal end of pedicles of about the same length. These pedicles (fig. 7, *sp*) are slender cylindrical tubes, very contractile, and covered with a series of small bracts. (The insertions of the detached bracts are visible in fig. 6, *sp*.) Usually four larger bracts (comparable to a quadripartite umbrella) arise from the base of the pedicle and cover its whole length (fig. 7, *b*). The siphon itself has a subspherical thick-walled basigaster, the cnidocysts of which are sometimes arranged on four square radial plates (figs. 7, 8, *sb*). The ovate stomach (*sm*) possesses sixteen red longitudinal liver-ridges, which are disposed regularly in a very remarkable manner (fig. 7, *sh*). Four larger perradial ridges extend throughout the whole length of the stomach, while four interradial, alternating with them, are shorter; and between the former and the latter are interpolated in the basal part of the stomach eight smaller adradial ridges. The contractile proboscis (*sr*) has four stronger longitudinal muscular bands. Its distal mouth exhibits sometimes eight, at other times sixteen, distinct lobes (fig. 8, *so*), which are separated in pairs by constrictions and armed with cnidocysts (fig. 9).

Tentacles (figs. 1, 7, *t*, 8, *t*, 23).—The single tentacle, which arises from the basigaster of each siphon (at the distal end of the long pedicle, fig. 8, *sp*), is very long and strong, distinctly articulate, and beset with a series of very numerous tentilla which arise from the equidistant nodes (fig. 7, *t*). Each tentillum (fig. 23) is composed of three parts, a thin pedicle (*ts*), a large spiral cnidoband (*tk*), and a long slender terminal filament (*tf*). The spiral cnidoband (or "cnidobattery") is naked, without involucre, has usually four open spiral turnings (like a corkscrew), and is composed of innumerable small paliform cnidocysts, with a lateral series of larger ensiform cnidocysts on each side. The peculiar arrangement, exhibited by the small fusiform cnidocysts in the terminal filament, is represented in fig. 23A from its proximal part, figs 23B and 23C from the middle parts, and fig. 23D from the distal part.

Cystons (Pl. X. fig. 19).—The cystons or anal vesicles, one of which arises from the trunk of the siphosome between every two siphons, are smaller than the latter, but larger than the neighbouring palpons. Each cyston is composed of four segments, which are comparable to those of the similar siphon. The first segment is a slender and thin pedicle (*qp*), not covered with bracts, and annulate towards the club-shaped distal end. The second segment is a thick-walled hemispherical basigaster, with thickened exoderm, full of cnidocysts; it bears the long palpacle (*r*). The third segment (fig. 19, *q*) is a long thin-walled cylindrical tube, comparable to the stomach of the siphon, but without the characteristic liver-ridges of the latter; it is separated by an annular constriction from the basigaster at the proximal, and from the colour-gland at the distal end. The fourth and last segment of the cyston is the colour-gland (chromadenia), a pyriform or conical vesicle of a dark red colour, with a terminal mouth-opening, or rather an anus. Its thick glandular entoderm secretes a mass of red pigment-granules, which often fill up and expand the terminal vesicle. When the animal is attacked or irritated, it opens the anus

spontaneously and ejects the masses of red pigment-granules which darken the sea-water.

Palpons (Pl. X. fig. 20).—The tasters seem to occur between the siphons in variable number and arrangement, sometimes a single one in each cormidium, at other times two or even three associated. They are similar to the cystons, but smaller and without a terminal opening. Each palpon is a spindle-shaped or pyriform vesicle, separated from its thin pedicle by a ring composed of cnidocysts, which corresponds to the larger basigaster of the cystons and siphons. The closed distal end is more or less pointed, and armed with patches of small cnidocysts (fig. 20). From the cnidal ring of each palpon arises, just as from the basigaster of each cyston, a very long and thin palpacle (fig. 19, *r*) or a tasting filament, which is beset with numerous small cnidocysts. The variable arrangement of the latter is represented by fig. 19B in the proximal part, fig. 19A in the middle, and fig. 19C in the distal part of the palpacle.

Gonophores (Pl. IX. fig. 7, *f*, *h*; Pl. X. figs. 21, 22).—Each cormidium bears a pediculate monostylic gonodendron, which is composed of a sexual palpon and numerous clustered gonophores, females in the proximal part and males in the distal part. The sexual palpon or gonopalpon (figs. 7, *q*, 21) is a spindle-shaped vesicle, which bears at its base a pair of crescentic patches, composed of larger spherical cnidocysts; its apex is densely covered with smaller cnidocysts. The female gonophores (fig. 21, *f*) are pyriform or subspherical; each contains a single large ovum only, surrounded by a loose network of irregular spadicine canals. The male gonophores (figs. 21, *h*, 22) are ovate or club-shaped, with a simple central spadix (*hx*). The umbrella in both sexes closely embraces the manubrium, and exhibits the usual four radial canals, connected by a very small ring-canal above the velum.

Genus 52. *Forskaliopsis*,[1] n. gen.

Definition.—Forskalidæ with loose cormidia and unsegmented trunk of the siphosome. Gonodendra monostylic, arising from the trunk, separate from the siphonal pedicles. Siphons with hepatic ridges. Nectosome with palpons.

The genus *Forskaliopsis* comprises those forms of Forskalidæ, the typical representative of which is the Mediterranean *Forskalia ophiura*, Leuckart; it differs from the true *Forskalia* (hitherto confounded with it) in several important characters. The trunk is not articulated, without annular constrictions, and everywhere densely covered with innumerable bracts in the same manner as the long pedicles of the siphons. The nectosome is distinguished by the presence of numerous tasting palpons scattered between the nectophores (8, p. 352); these are wanting in *Forskalia*, and remind one of the nectosome of *Apolemia*. The numerous cormidia in the large siphosome of

[1] *Forskaliopsis*=Similar to *Forskalia*.

Forskaliopsis seem to be looser, and their organs more irregularly scattered than in the preceding *Forskalia*. The palpons of the former are much more numerous, often three, four, or more arising from a common pedicle. Perhaps other constant differences may be found between these two genera, which are also rather different in external appearance. *Forskaliopsis* is one of the largest and most splendid Physonectæ; its size in the fully expanded state attains more than a metre, and the number of nectophores as well as of siphons amounts in the larger specimens to five hundred or more, the number of bracts to several thousands. I observed a gigantic representative of this splendid genus, *Forskaliopsis magnifica*, distinguished by the blackish-brown colour of the siphons and cnidocysts, in 1881, in the Indian Ocean; but unfortunately it was destroyed before I could examine it sufficiently.

Genus 53. *Bathyphysa*,[1] Studer, 1878.

Bathyphysa, Studer, Zeitschr. f. wiss. Zool., Bd. xxxi. pp. 21, 24.

Definition.—Forskalidæ with loose cormidia and unsegmented trunk of the siphosome. Gonodendra distylic (?), arising from the trunk, separate from the siphonal pedicles. Siphons with hepatic villi and a pair of lateral wings. Nectosome probably with palpons between the nectophores (?).

The genus *Bathyphysa* (perhaps the representative of a separate family, Bathyphysidæ) was established in 1878 by Studer for a gigantic deep-sea Siphonophore, which surpasses all other animals of this class in the extraordinary size of the siphons and of the gonodendra. It was taken by the S.S. "Faraday" in 1875, on the occasion of the third Atlantic Cable Expedition, and brought up by a grapnel from depths of 1000 and 1780 fathoms, in the North Atlantic (lat. 43° 45′ N., long. 43° 36′ W.). The fragments of this most interesting genus, preserved in the Zoological Museum of Berlin, are unfortunately very incomplete, partly without connection, and do not allow us to compose a satisfactory idea of the complete structure and the natural affinities of the genus. The strong tubular trunk of *Bathyphysa abyssorum*, which even in the highly contracted state has a length of more than a metre, is divided into two halves of very unequal thickness. The proximal or superior half is only 3 to 5 mm. in diameter and is the trunk of the nectosome; it bears at its apex an ovate pneumatophore of 20 mm. in length, and beyond it numerous lateral apophyses (not mentioned by Studer, but figured by him in fig. 28, *loc. cit.*), which are probably the bases of the pedicles of the detached and lost nectophores. The distal or inferior half of the trunk is much thicker (10 to 15 mm. in diameter), laterally compressed, and beset in the ventral median line with two series of numerous appendages, siphons and gonodendra alternating. The thin tubular pedicles of the siphons attain a length of 20 centimetres, and bear numerous pisi-

[1] *Bathyphysa* = Deep-sea-float, βάθυς, φῦσα.

form prominences ("erbsengrosse Anschwellungen"), probably the basal parts of the detached and lost bracts. The siphons themselves (in a strongly contracted state) attain a length of 50 to 60 mm. and a thickness of 30 mm., and are therefore much larger than in any other known Siphonophoræ; in the fully expanded state they may have a length of half a metre or more. The basal half of the spindle-shaped siphons is distinguished outside by the possession of two opposite lateral wings or crests. Their whole inside is covered with innumerable small villi, which replace the wanting hepatic ridges. The gonodendra, which seem to alternate with the siphons, are elegant oblongish bunches 70 mm. to 80 mm. in length and 10 mm. to 15 mm. in breadth, attached directly to the trunk by thin tubular pedicles of nearly the same length. Each gonodendron is richly branched, and bears many hundreds of pediculate ovate gonophores, about 1 to 1·5 mm. in diameter. The bad state of preservation did not allow the recognition of their structure; but all the gonophores in each gonodendron seemed to be of the same sex.

Unfortunately the bracts as well as the nectophores were all detached and lost in the fragments of the corm described by Studer; but the great facility with which these parts are detached in all Forskalidæ explains their complete absence sufficiently; and the more so, as the mode of capturing this gigantic deep-sea form, brought up on a grapnel from depths of 1000 to 1800 fathoms, must have injured the delicate corm in the most violent manner. The tentacles which were originally attached to the base of the siphons were also found separate from them; they bore a series of tentilla, with ovate cnidosacs 12 to 15 mm. in length and 4 to 5 mm. in thickness; their spiral cnidoband had numerous turnings. Similar to the siphons, but of half their size, and provided with two larger longitudinal wings, were detached bodies, which Studer has described as "bracts" (*loc. cit.*, p. 20, Taf. iii. fig. 25); they are probably cystons.

Probably to the same genus belongs a gigantic deep-sea form, the detached siphons of which Fewkes has described in 1886 as *Pterophysa grandis*, taken from a depth of 2109 fathoms in the Gulf Stream (**45**, Nr. xxxvi. p. 960, pl. x. figs. 1–3). Scattered fragments and detached parts of another large Forskalid, probably closely allied, were found in a bottle in the Challenger collection taken in the South Atlantic (Station 323, depth 1900 fathoms). It may be called provisionally *Bathyphysa gigantea*.

Family XV. Nectalidæ, Haeckel, 1888.

Nectalidæ, Hkl., System der Siphonophoren, p. 41.

Definition.—Physonectæ polygastricæ, with a short vesicular stem of the siphosome, bearing numerous siphons, palpons, and bracts, each siphon provided with a branched tentacle. Nectosome with two or four rows of nectophores. Pneumatophore with radial pouches.

The family Nectalidæ is founded by me for the interesting new genus *Nectalia* (Pl. XIII.), to which probably *Sphyrophysa* of L. Agassiz (36) is closely allied. They have in general a similar organisation to the well-known Discolabidæ (*Physophora*), but differ from them essentially in the possession of a large protecting corona of cartilaginous bracts at the apex of the siphosome.

Nectosome and Siphosome.—The corm of the Nectalidæ is composed of a long columnar nectosome and a flat coroniform siphosome. The trunk of the nectosome is a slender vertical tubule, and bears either two opposite or four cruciate rows of nectophores; and at the apex a pneumatophore with four radial chambers. The trunk of the siphosome is shortened, vesicular, and horizontally expanded in form of a spiral bladder, to which are attached the following parts:—Uppermost a corona of bracts, beyond it a corona of palpons or cystons, below a bunch of siphons and tentacles, and at the distal base a group of clustered gonophores. Probably these polymorphous persons and organs are arranged regularly in ordinate cormidia, as in *Physophora;* but in the single specimen observed by me it was impossible to make out this metameric arrangement with full certainty. I suppose, however, that each nectophore belonged originally to a cormidium, which was composed of the following parts: One bract, one palpon, one siphon with a tentacle, and two gonodendra, a male and a female.

Pneumatophore (Pl. XIII. figs. 1–3, *p*, 4).—The float, placed at the apex of the siphosome, is in *Nectalia* pyriform, and exhibits four vertical radial septa, which connect the outer with the inner wall; the cavity of the pneumatosac is divided by them into four large radial pouches. An opening at the apex of the pneumatocyst was not visible, but there seems to be one at its base (just as in *Physophora*).

Nectophores (figs. 1, *n*, 5–8).—The column of nectocalyces in *Nectalia* is composed of two opposite longitudinal rows, in *Sphyrophysa* of four cruciate rows; the former bears therefore the same relation to the latter as in the following family *Physophora* does to *Discolabe*. The nectophores are similar in form and structure to those of many other Physonectæ, and they embrace the trunk of the siphosome so fully by two apical horns or wings, fitting in the space between two obliquely opposite nectophores, that the structure of the nectosome becomes very solid. The subumbrella of the nectophores has a strong muscle-plate, and renders possible a very rapid movement of the swimming corm. The velocity of the swimming *Nectalia* is much greater than that of most other Physonectæ, and comparable to that of *Diphyes*, *Sagitta*, and *Loligo*.

Bracts (figs. 1, 9–12).—The prominent character of the family Nectalidæ is found in the corona of bracts, which is attached to the apex of the siphosome immediately beyond the base of the nectosome; it is similar to that of the Anthophysidæ, and is wanting in the Discolabidæ, which are otherwise nearly related. The bracts of *Nectalia* are strong cartilaginous covering scales of a peculiar form and differentiation, especially described below. They are raised and subhorizontally expanded in the quietly-floating

corm, whilst they form a closed bilaterally compressed calyx in the rapidly swimming animal.

Palpons (*q*).—The corona of palpons, which is placed immediately beyond the corona of bracts in the Nectalidæ, is comparable to that of the Anthophysidæ as well as of the Discolabidæ. The number of palpons, however, is much smaller than in the last two families, and seems not to exceed that of the superjacent bracts. It may be that each palpon and the appertaining bract originally composed a medusome, the former representing its manubrium, the latter its reduced umbrella. The distal end of the tubular, very mobile palpons, seems to possess a mouth-opening (fig. 2, *qo*), and in this case they should be called cystons. Palpacles or tasting filaments were not observed.

Siphons (*s*).—The large polypites of *Nectalia* exhibit distinctly the four usual segments, a short pedicle, a basigaster with very thick wall filled by cnidocysts (figs. 2, 13, *sb*), a stomach *sm*), the inside of which bears longitudinal rows of glandular villi (*sv*), and a very extensile and contractile proboscis with a thick muscular wall (*sr*). The distal mouth of the latter is four-lobed (*so*).

Tentacles (*t*).—The long tubular tentacle which is attached to the base of each siphon bears a series of numerous tentilla. The cnidosac of the latter includes in *Nectalia* a strong, spirally-twisted cnidoband, and bears at its distal end a simple terminal filament; the latter is replaced in *Sphyrophysa* by an odd terminal vesicle and two lateral horns. The difference between the two genera is therefore similar to that between *Stephanomia* and *Agalma*, or between *Halistemma* and *Agalmopsis*.

Gonophores.—The corms of *Nectalia* are monœcious and the cormidia monoclinic, since two clustered gonodendra, a male and a female, are attached near the base of each siphon. The medusoid gonophores are very small and numerous, and have a reduced umbrella. As usual, the spermaria are oblong or spindle-shaped, the ovaria roundish or subspherical.

Genus 54*a*. *Nectalia*,[1] Haeckel, 1888.

Nectalia, Hkl., System der Siphonophoren, p. 41.

Definition.—Nectalidæ with a biserial nectosome, composed of two opposite rows of nectophores. Cnidosacs of the tentilla with a simple terminal filament.

The genus *Nectalia*, as the type of this family, is represented by the North Atlantic species figured in Pl. XIII. It is similar to *Physophora*, but differs from it essentially in the corona of large bracts which separates the biserial nectosome and the flower-shaped siphosome. The cnidosacs of the tentilla bear a simple terminal filament.

The single specimen of this genus which I have examined, and which is described in the sequel, I captured by scooping it up with a glass vessel without touching it, on

[1] *Nectalia* = Swimming in the sea; νήκτης, ἅλιος.

January 15, 1867, in the Canary Island Lanzerote. Quietly expanded on the surface of the water, it had the form drawn in fig. 1, but this lasted only a few minutes. Most of the time the animal was in continuous very rapid motion, quite unusual among the Physonectæ. It swam through all parts of the vessel very quickly, without touching its sides, with rapidly succeeding contractions of the nectophores. The siphosome was in the swimming animal strongly contracted, the corona of bracts closed, and the strong bilateral compression of the corm, with two sharp opposite keels in the sagittal plane, seemed to be excellently adapted for the rapid swimming motion.

Nectalia loligo, n. sp. (Pl. XIII.).

Habitat.—North Atlantic, Canary Islands, Lanzerote, January 15, 1867 (Haeckel).

Nectosome (figs. 1–8).—The swimming apparatus is composed of a rather long tubular trunk, which bears at the apex a pyriform pneumatophore, and beyond it a double series of opposite nectophores in four pairs obliquely. The length of the nectosome is 20 mm. to 25 mm., and about equals that of the largest bracts of the siphosome. There was a group of buds of nectophores at the base of the pneumatophore, marking the blastocrene of the nectosome, or its point of vegetation.

Pneumatophore (figs. 1, 2, 3, *p*, 4).—The float at the apex of the nectosome was in the living animal pyriform, with a red apex and an oblongish pneumatocyst filling up its upper half (fig. 1, *pf*). Preserved in alcohol (fig. 4) it appeared under an altered form, subcylindrical, with two annular constrictions of the included pneumatocyst (*pf*). The pneumatosaccus surrounding the latter is rather wide, and connected with the pneumatocodon by four cruciate radial septa or vertical mesenteria (*pr*). The pericystic cavity of the pneumatophore, therefore, is divided into four radial pouches (*ps*).

Nectophores (figs. 1, *n*, 3, *in*, buds, fig. 5, a young nectophore, figs. 6–8, adult nectophores, 6, dorsal view, 7, basal view, 8, lateral view from the left side).—The umbrella of the nectophores is strongly compressed in the direction of the sagittal axis, which is 3 mm. or 4 mm. long, half as great as the frontal and the principal axes (both 6 to 8 mm. in length). The truncate basis, with the ostium of the nectosac, is directed obliquely outwards, whilst the opposite apex has a deep square excision. The two lateral horns or wings, which are separated by the latter, are square in frontal view (fig. 6), triangular in lateral view (figs. 1, 8), of a three-sided prismatic form, and embrace the trunk of the nectosome, so fitting in the interval between the two opposite nectophores (superior and inferior) that they fill up the interval between them. The superior or dorsal face of the umbrella is slightly convex, with a median sagittal groove, and fitting exactly into the concave lower or ventral face of the next superior nectophore. In the median line of the ventral groove arises a sagittal ridge, which bears a short pedicle

(fig. 8, *cp*), serving for the attachment to the trunk. The two lateral faces of the umbrella, right and left, are strongly convex (figs. 6, 7).

Nectosac (*w*).—The subumbrella occupies about two-thirds of the nectophore, and is also strongly compressed in the sagittal direction. Its upper or dorsal face is concave, the lower or ventral convex. Its axial or proximal half is dilated, twice as broad as the abaxial or distal half. The latter opens by a narrow triangular mouth (*no*), which is surrounded by a small velum (*v*). The nectocalycine duct (fig. 8, *cp*), which enters through the pedicle of the nectophore, divides on the top of the nectosac into four radial canals of very different length and form. The shorter concave dorsal canal and the longer convex ventral canal run straight in the sagittal plane; whilst the two lateral canals (right *cx*, and left *cl*) are about three times as long, and form not less than four curved loops, the complicated course of which may best be seen by comparison of figs. 6–8. The small ring-canal, which connects the four radial canals at the mouth of the nectosac, makes a simple bend in the dorsal half, a pair of loops in the ventral half (fig. 7, *cc*).

Siphosome (fig. 1 drawn from the living specimen; fig. 2 from the same dead, in contracted state, after detachment of the bracts and nectophores).—The inferior half of the corm, below the nectosome, has the aspect of a flower, which is compressed from two sides, in the same direction as the bilateral nectosome. The trunk of the siphosome (fig. 3, *as*) is an ovate vesicle, which bears a series of buds (*is*) in the median line of its ventral side, as an inferior continuation of the superior series of buds of nectophores (*in*). The polymorphous appendages, which arise from the bud series, are so disposed that immediately beyond the nectosome a corona of bracts is expanded. Below this follows a corona of cystons or mouth-bearing palpons, and inside of these a group of siphons (*s*) with the tentacles (*t*); finally, at the distal base the bunches of gonophores. When we compare the composition of the siphosome with that of a dichlamydeous flower, then the bracts correspond to the calyx, the cystons to the petals, the siphons to the stamens, and the gonophores to the pistils. If the animal floats quietly at the surface of the sea, then the calyx is opened and the petals and stamens expanded (fig. 1); but when it swims quickly by the action of the nectophores, then the calyx is closed and the appendages included in it form a dense, bilaterally compressed bunch.

Bracts (figs. 1, 9–12).—The corona of large and firm cartilaginous bracts or covering scales, which expands beyond the nectosome and covers the other parts of the siphosome, exhibits a very remarkable composition, not observed hitherto in any other Siphonophoræ. The corona has an amphithect fundamental form, compressed from the two lateral sides of the corm, and is composed of eight foliaceous, symmetrically arranged bracts (fig. 1). A pair of larger and slender lateral bracts (figs. 11, 12) is placed on the two poles of the frontal axis of the trunk (right and left); they are 25 mm. long, 5 to 6 mm. broad. A second pair of bracts, which have the same breadth, but only one-third of the length

(fig. 9), covers the two poles of the sagittal axis (dorsal and ventral pole), and lies therefore immediately beyond the two lowermost nectophores. Between the former and the latter (in two crossed diagonal axes) lie two pairs of opposite bracts of medium size (fig. 10). Each bract has a concave ventral or axial face, and a convex dorsal or abaxial face, in the median line of which arises a prominent crest or keel (*bd*). A simple bracteal canal (*cb*) runs near the ventral side, in the median line, and ends blindly near the distal apex. The two lateral margins form a pair of thin lamellar wings, each with a prominent tooth towards the distal end. The base of the bract (*bb*) bears a curved hook, for insertion into the trunk; and the opposite distal apex is provided with a bunch of cnidocysts. These are wanting, however, in the two large lateral bracts, which appear straight in profile (fig. 12), whilst the other six have a sigmoidal curve (fig. 10). The two large and very vigorous lateral bracts may act in the rapidly swimming animal like the so-called "swords" in a sailing boat. *Nectalia loligo* has a more rapid swimming motion than any other known Physonect, and agrees in this with *Diphyes*, *Sagitta*, and *Loligo*.

Palpons (*q*).—Immediately beyond the corona of bracts is placed a corona of palpons or tasters, comparable to that of *Physophora*, but much less developed. The number of palpons which are attached to the trunk close inside the base of the bracts seems to correspond to that of the latter. Their body is a long and slender cylindrical tubule, very mobile and flexible. The palpons may be perhaps better called cystons, since they seem to possess a mouth-opening at the distal end (fig. 2, *qo* ?). I could, however, not be absolutely certain on this point.

Siphons (figs. 1, 2, *s*, 13).—The number of fully-developed siphons was in the single specimen observed four, and they were attached to the base of the vesicular trunk of the siphosome, inside the corona of palpons. When fully expanded and prominent between the bracts (fig. 1) the siphons were longer than the latter (up to 30 mm.). The short pedicle of the siphon bears a pyriform basigaster (*sb*), and upon this an ovate, very dilatable stomach (*sm*); its inside exhibits eight to twelve or sixteen longitudinal rows of prominent, glandular, red-coloured villi (*sv*). The following proboscis (*sr*) is a cylindrical, very mobile tube with a thick muscular wall; its entoderm is in some siphons red. The mouth at its distal end is often dilated, and its opening, also reddish, square or provided with four short lobes (*so*).

Tentacles (figs. 1, *t*, 2, 14).—Each siphon bears at its base a long tentacle, beset with a series of numerous tentilla. The latter (fig. 14) have a long pedicle (*ts*), a large cnidosac (*tk*), and a simple small terminal filament (*tf*). The cnidosac has a peculiar form, being composed of two large subspherical ampullæ (one proximal, tk_{I}, and one distal, tk_{III}), and between both a cylindrical middle part (tk_{II}), which contains a large cnidobattery (tk_{IV}). This latter is a long spiral riband of four to five coils, composed of innumerable small paliform cnidocysts (fig. 15) and two lateral rows of large ellipsoidal cnidocysts (fig. 16).

Gonophores.—The sexual medusomes are placed at the distal base of the siphosome, below and inside the siphons. There seems to be a couple of clustered gonodendra (a male and a female) attached to the base of each siphon, composing with it (and with the appertaining palpon and bract) an ordinate monoclinic cormidium. The gonostyle of the male as well as of the female gonodendron is richly branched, the number of gonophores large, their size small. The spermaria are oblongish, the ovaria roundish, as usual. The umbrella is reduced. The special structure of the gonophores, which I could not sufficiently examine, seems to be similar to that of *Physophora*.

Genus 54*b*. *Sphyrophysa*,[1] L. Agassiz, 1862.

Sphyrophysa, L. Agassiz, Contrib. Nat. Hist. U. S., vol. iv. p. 368.

Definition.—Nectalidæ with a quadriserial nectosome, composed of four cruciate rows of nectophores. Cnidosacs of the tentilla with three terminal appendages, an odd median ampulla, and two lateral horns.

The genus *Sphyrophysa* was established by L. Agassiz for the Physonect which Quoy and Gaimard had found in the Tropical Atlantic (lat. 7° N.) in February 1829, and figured under the name *Physophora intermedia* (**2**, p. 56, pl. i. figs. 10–18). As far as it is possible to recognise it from their incomplete representation, it seems to be closely allied to the preceding *Nectalia*, but differs from it in two essential characters of generic value. The nectosome seems to be composed not of two opposite, but of four cruciate rows of nectophores (as in *Discolabe* among the Physophoridæ). The cnidosacs of the tentilla are tricornuate, and bear at the distal end an odd median vesicle and two paired lateral horns (as in *Agalma*, &c.).

L. Agassiz also has placed in the same genus, *Sphyrophysa*, the similar Physonect which Huxley had described as *Agalma breve* (**9**, p. 75, pl. vii.). But this species is probably a true *Agalma*, and more allied to the form which Leuckart has described as *Agalma clavatum* (compare above, p. 226).

Family XVI. Discolabidæ, Haeckel, 1888.

Discolabidæ, Hkl., System der Siphonophoren, p. 41.
Physophoridæ, Huxley, et multor. autor.

Definition.—Physonectæ polygastricæ, with a short vesicular stem of the siphosome, bearing numerous siphons and a corona of large palpons (instead of the wanting bracts), each siphon provided with a branched tentacle. Nectosome with two, four, or more rows of nectophores. Pneumatophore with radial pouches.

[1] *Sphyrophysa* = Hammer-bladder, σφῦρα, φῦσα.

The family Discolabidæ comprises those polygastric Physonectæ, the nectosome of which is well developed, with a long trunk and two or more series of nectophores, whilst the trunk of the siphosome, without bracts, is shortened and subhorizontally expanded in the form of a wide spiral bladder, the ventral periphery of which bears a series of ordinate cormidia, protected by a corona of large palpons.

The well-known type of this family is the Mediterranean *Physophora hydrostatica*, figured and described in 1775 by Petrus Forskål. Its accurate anatomical description was given in the years 1853 to 1860 by Kölliker (**4**), Vogt (**6**), Gegenbaur (**10**), and Claus (**34**). Huxley (**9**) established for this genus the family Physophoriadæ and gave to it the following definition :—" Physophoridæ with nectocalyces, but without hydrophyllia. The distal end of the filiform cœnosarc dilated. Tentacular branches with involucrate sacculi. Pneumatocyst small." The name Physophoridæ for this family has also been retained by later authors; but unfortunately it is employed with no less than four different meanings, and therefore has lost all value (compare above, p. 186). It may be, therefore, best to call this family Discolabidæ, from another genus belonging to it, *Discolabe* (Eschscholtz, **1**, p. 155). A third genus is *Stephanospira* of Gegenbaur (**10**, p. 67).

Nectosome.—The swimming apparatus of the Discolabidæ is composed of numerous large nectophores, arranged in various ways around the vertical tubular trunk, and of an apical pneumatophore at the top of the common trunk. Usually (in the typical *Physophora*) the nectosome is biserial (*disticha*), as in the Agalmidæ, composed of two opposite longitudinal rows of nectophores (usually four to six pairs). *Discolabe* differs in having a quadriserial nectosome (*tetrasticha*), similar to *Sphyrophysa;* it is composed of four cruciate longitudinal series of nectophores (or of four to six quadriradiate coronas). *Stephanospira*, finally, has a conical or multiserial nectosome (*polysticha*), similar to that of the Forskalidæ; the nectophores are here very numerous and arranged in a long continuous spiral, with four to six or more turns. The trunk of the nectosome, after the detachment of the nectophores, is a cylindrical, or in the contracted state, spindle-shaped bladder, which bears on its ventral side a lamellar longitudinal fold, like a mesentery, and at the free edge of this a series of spirally convoluted folds, the insertions of the detached nectophores. The tapering proximal end of the vertical spindle-bladder is separated by a constriction from the pneumatophore, and the broader distal end by a similar constriction from the inflated trunk of the siphosome (Pl. XX. figs. 9–12).

Pneumatophore (figs. 1, *p*, 9–13, *p*).—The float filled with air has in the Discolabidæ the same structure as in the Agalmidæ. It is ovate or subcylindrical, with a red pigment-spot at the apex, and with a variable number (usually eight) of longitudinal ribs in the outer wall. These arise in the lower half as eight (more rarely seven or nine) vertical radial septa, which connect the inner with the outer wall and divide the

pericystic cavity into the same number of radial pouches. Claus (**74**, p. 22) and Korotneff (**50**, p. 272) have described peculiar cæcal canals in the wall of the radial septa; but these hypothetical canals are in fact solid fibres composed of exoderm cells, and arising from the pneumadenia (or the air-secreting exoderm of the infundibulum), as has been shown by Chun (**48**, p. 514). The apex of the pneumatophore has no opening; but there is a stigma, or a constant opening through which the air is emitted, at the base of the pneumatophore, in the median line of its dorsal side, opposite to the ventral buds of the youngest nectophores; its place corresponds to that point where, in the Auronectæ, the aurophore is situated. Keferstein and Ehlers (**33**, p. 3) have already described the spontaneous emission of air by this stigma, and I have repeated the same observation in the Canarian *Physophora magnifica* (**84**, p. 35, pl. iii. fig. 26).

Nectophores (Pl. XIX. figs. 1–4).—The nectocalyces are in general very similar in form to those of the Agalmidæ. The bilaterally symmetrical umbrella is attached to the trunk by a lamellar triangular pedicle, which arises in the middle line of its concave ventral side. The opposite dorsal side is more or less convex. The principal axis is directed obliquely from above and within, downwards and outwards, so that the apical pole is situated more highly than the basal pole with the ostium. This latter is obliquely truncate, often with a pair of lobiform apophyses on the ventral side. The axial or apical half of the nectophore is always much broader than the basal half, and provided with a pair of auricles or apical horns which embrace the stem. Correspondingly, the large nectosac, which is not much smaller than the surrounding umbrella, is cordate and composed of three parts, a smaller odd basal part and a pair of large lateral lobes; the former is subcylindrical or subconical, the latter are subovate or trapezoidal. The four radial vessels are of very different shape, since the two paired lateral canals enter into the two dilated auricles; they form here several loops, and are therefore much longer than the two sagittal canals (shorter ventral and longer dorsal) which run simply curved in the median plane of the nectosac. The circular canal which connects the four radial canals above the insertion of the velum is small and ovate, corresponding to the small ostium of the nectosac. (Compare **10**, Taf. xxx. figs. 33–35; **34**, Taf. xxv. figs. 6–8; **27**, Heft iii. Tab. vi. figs. 1–4, &c.)

Siphosome (Pl. XX. figs. 9–13).—The trunk of the siphosome in the Discolabidæ was regarded by all former observers as a simple sac-shaped and inflated dilatation of the blind basal part of the trunk of the nectosome, and the general opinion was, that the different appendages, beyond the corona of tasters, were more or less irregularly crowded at its basal face (with loose cormidia). This error was not corrected until the year 1877, when the excellent figures of *Physophora borealis* by M. Sars were published in the third part of the Fauna littoralis Norvegiæ (**27**, Heft iii. Taf. v. figs. 1–6). This celebrated observer had discovered, many years before, that the siphosome of *Physophora* is expanded subhorizontally, beyond the nectosome, in form of a large, reniform, spirally-twisted sac,

with an asymmetrical incision, and that the different polymorphous appendages are attached in regular order to the peripheral convex margin of their discoidal sac. This margin is divided by a series of equidistant radial constrictions into a number of roundish polygonal or quadrangular facettes (ten to twenty or more). Each articular facette is surrounded by a prominent muscular wall or frame, and bears a single large palpon with its palpacle, and beyond it is attached a single siphon with its tentacle; in the interval between them is a pair of gonodendra, a proximal female and a distal male. The cormidia are, therefore, perfectly ordinate, and succeed one to another regularly in the subhorizontal ventral median line of the depressed trunk of the siphosome (compare figs. 9 to 13). The observations of Sars (already made in 1857) were twenty years afterwards confirmed and more fully carried out by Claus (in 1878, **74**, Taf. iii. figs. 1–4). Moreover, Gegenbaur had already (in 1859) described in *Stephanospira* the spiral twisting of the discoidal inflated trunk, and the regular order in which the siphons and the paired gonodendra (a male and a female) were attached to the peripheral margin of the spiral disc; hence he derived its name. The spiral twisting in the siphosome of all Discolabidæ seems to be dexiotropic, opposite to the læotropic spiral of the nectosome; Claus, who calls the former also læotropic, seems to have confounded the proximal and the distal part of the spiral (**74**, p. 13).

Cormidia.—The numerous ordinate cormidia which compose the siphosome of the Discolabidæ, are disposed along the ventral median line of its trunk not less regularly than in the Apolemidæ and the polygastric Calyconectæ. The only difference is, that the naked internodes are in the latter very long, in the former very short; but they are sharply marked by the limits of the facettes, or the basal insertions of the single groups of medusomes. The effective cause of that difference is the divergent development of the trunk of the siphosome; this is tubular and much prolonged in a vertical direction in the Apolemidæ, as in the Agalmidæ; it is vesicular, much shortened and inflated, and coiled up spirally in a subhorizontal direction in the Discolabidæ, as in the Nectalidæ. The trunk of the latter possesses, therefore, permanently about the same shape which the trunk of the former exhibits only in the state of the strongest contraction.

The composition of the ordinate cormidia is in all the three genera of Discolabidæ essentially the same. Descending from the proximal or apical (superior and external) face of the trunk, towards the distal or basal (inferior and internal) face, we find successively the following parts:—(1) a large palpon with its palpacle; (2) a female gonodendron; (3) a male gonodendron; (4) a large siphon with its tentacle. Sometimes the number of palpons is doubled, so that a pair of them (a larger superior and a smaller inferior) belong to each cormidium; but it seems that this duplication is often accidental, and variable in one and the same species.

Siphons (Pl. XX. figs. 13, 16, *s*).—A single large polypite is attached to the distal side of each cormidium, and occupies therefore the innermost place on the subhorizontal basal

face of the spirally coiled up trunk. When we regard the latter from below, after the detachment of the siphons, the remaining pedicles of these form an innermost spiral line (fig. 12, *sp*) inside the spiral corona of gonodendra. In *Stephanospira* these pedicles were regarded by Gegenbaur as the siphons themselves (**10**, Taf. xxxii. fig. 53, *e*). In spirit specimens of Discolabidæ the siphons are usually all detached from their pedicles, which remain as short conical prominences connected with the trunk (compare **6**, pl. iv. fig. 5). The body proper of the siphon consists of the usual three segments. The proximal basigaster is very large and occupies in the contracted siphon about its basal half; its thickened wall is full of small cnidocysts and surrounds a narrow cylindrical cavity (**6**, pl. iv. fig. 5). The stomach proper is very dilatable, usually ovate or spindle-shaped, and exhibits either hepatic ridges, or instead of these numerous glandular villi developed from its thickened entoderm. The distal proboscis is cylindrical, very contractile, and exhibits usually eight, twelve, or sixteen parallel longitudinal muscle-bands; it opens distally by a mouth which is very dilatable and may be expanded in the form of a circular or slightly lobate suctorial disc. Often this distal part is turned over like the inverted finger of a glove (**6**, pl. iv. figs. 4–6).

Tentacles (Pl. XIX. fig. 1; Pl. XX. figs. 13, 16, *t*, 14).—The single tentacle, which is attached to the pedicle of each siphon, near to the insertion of the basigaster, is in all Discolabidæ very long and beset with a series of very numerous and large tentilla. The cnidosac of the latter has a peculiar structure, differing from that of all other Siphonophoræ. The fully-developed tentillum is composed of two segments only, a very large pedicle and a large involucrate cnidosac; the third and distal segment, the terminal filament, has disappeared. The pedicle again is often divided into two portions, a thin cylindrical proximal tube, and an inflated vesicular distal sac, usually club-shaped or pyriform. The cnidosac (sacculus or urticating knob) is ovate, spindle-shaped, or pyriform, bilaterally ysmmetrical, with a more convex dorsal and a less convex or even concave ventral side; it contains, included in a double involucre, a very long cnidoband or urticating chord, coiled up in several spirals. The latter is composed of innumerable small, paliform cnidocysts, and of two lateral series of large ensiform or spindle-shaped cnidocysts. These latter are placed at the distal end of the vesicular cnidosac, whilst they are situated in the other Siphonanthæ usually at its proximal end.

This apparent anomaly, and the divergence in structure from the normal form, is fully explained by the development of the cnidosac; it passes during its ontogeny through different stages, which are represented by the permanent cnidosacs of the genera *Circalia*, *Stephanomia*, *Halistemma*, and *Agalmopsis*. The simple cylindrical tubule of the youngest tentillum becomes divided into the three usual portions, the pedicle, the cnidoband, and the terminal filament. The middle one of these is spirally coiled up as a simple and naked spiral cnidoband. The distal portion of the pedicle becomes inflated, forms a campanulate fold around the top of this band, and grows around it entirely,

forming a complete external involucre. The canal of the pedicle runs along the extended and convex dorsal side of the involucre, which overgrows the ventral side. The axis of the spiral cnidoband, originally vertical, becomes more and more inclined, is afterwards horizontal and perpendicular to the axis of the pedicle, and finally inverted completely, so that the original distal end of the cnidoband is situated at the proximal base of the cnidosac, on its ventral side. The terminal filament, originally the simple prolongation of that distal end, is early divided into three apophyses, an odd median (the terminal ampulla) and two paired lateral horns (as in *Agalma*, &c.). But these are not fully developed (being rudimentary organs) and disappear finally. The basal point of their original insertion remains visible at the distal end of the reflected cnidoband, near the proximal base of the cnidosac, in its ventral median line. Compare the full description of this interesting metamorphosis by Gegenbaur (**10**, p. 63, Taf. xxx.), Claus (**34**, pp. 295 *et seq.*, Taf. xxvi.), Keferstein and Ehlers (**33**, p. 10, Taf. iv.), Sars (**27**, Heft. iii. Taf. v.), &c.

Palpons (Pl. XIX. fig. 1, *q*; Pl. XX. fig. 16, *q*).—The large corona of palpons, which expands at the base of the nectosome and covers the entire siphosome as a protective roof, is very characteristic of the Discolabidæ. The tasters or palpons are in this family far larger and relatively far more developed than in all the other Siphonophoræ. They are not only organs of feeling and tasting, but also of capturing and protecting; they were, therefore, formerly confounded with other organs; Vogt described them erroneously as bracts (**6**), and Claus as tentacles (**34**). Each cormidium possesses either a single or two palpons, a larger proximal and a smaller distal; and the corona, therefore, is either simple or double. This difference may perhaps serve also for the definition of genera, as I have employed it in my System (**95**, p. 41). *Discolabe* and *Stephanospira* possess a simple corona of tasters, while it is double in *Physophora*. But in this latter also usually one corona only (the upper and larger) is fully developed, and the accessory (lower and smaller) corona is incomplete or rudimentary. The development of the latter is variable in one and the same species (**74**, p. 15). Each palpon is a spindle-shaped, cylindrical, or slenderly pyriform tube, with a simple wide cavity and a very thick muscular wall; the structure of the wall is similar to that of the trunk; both the entoderm and exoderm are glandular; the fulcrum bears inside a plate of ring-muscles, outside numerous high radial folds which are covered with longitudinal muscles. The consistence of the fulcral plate is nearly cartilaginous (compare **74**, p. 43, Taf. v. fig. 7). The pointed and closed distal end of the palpon is provided with a corona of large cnidocysts and tasting cells. The dilated and obliquely truncated proximal end is apposed by a broad elliptical articular face to the facette of the siphosome described above, but connected with the latter by a very small pedicle only. The palpons, therefore, are very easily detached from the siphosome, and a small pore only in the middle of each articular facette indicates the place of the narrow canal which connected the wide cavities of the trunk and of the palpon (Pl. XX. figs. 9–13, *cq*).

Palpacles (Pl. XIX. fig. 1, *r*; Pl. XX. fig. 16, *r*).—From the upper face of the proximal base of each palpon arises a very thin tasting filament, usually two or three times as long as the palpon, but very extensible. It is usually described as an "accessory tentacle," and represents a narrow cylindrical tubule with a very thin muscular wall, distinctly articulated, like the antenna of a longicorn insect. The palpacles of the living Discolabidæ, quietly floating at the surface of the sea, are usually in a perpetual feeling motion, undulating, tasting, and protruding in all directions.

Gonostyles (Pl. XX. figs. 11–16, *q*).—The corms of all Discolabidæ are monœcious, and their cormidia monoclinic, each possessing two gonostyles, a male and a female. These are placed on the peripheral margin of the vesicular spiral trunk, between the siphon and the palpon of each cormidium, the male (*gh*) below the female (*gf*). The female gonostyle is placed beyond the palpon, richly branched, and forms in the developed state an ovate bunch composed of many hundred subspherical clustered gynophores. The male gonostyle (*gh*) is placed above the siphon, and is very different in form. It is a single, very large, undivided palpon, with very contractile muscular wall; cylindrical in the expanded, slenderly pyriform in the contracted state. It is often elongated, hangs down like a tentacle, and is densely beset with numerous oblongish or spindle-shaped androphores arising from short pedicles, either arranged spirally or scattered irregularly. When the ripe androphores in the distal part of the gonostyle are detached, their pedicles remain as short knobs or papillæ (fig. 16, *hp*). (Compare **27**, Heft iii. Taf. v. figs. 9–15.) The umbrella of the gonophores is small or rudimentary. The subspherical manubrium of the gynophores contains a single ovum only, and is much smaller than the oblongish manubrium of the androphores.

Ontogeny (Pl. XIX. figs. 5–8).—The larva which arises from the fertilised egg of the Discolabidæ is a Siphonula, the helmet-shaped umbrella of which (*b*) includes a pneumatophore (*p*) and has a deep ventral cleft. A large spindle-shaped siphon is suspended in the bilateral cavity of the umbrella or bract, beyond the pneumatophore, and at its dorsal side a tentacle, the tentilla of which bear each a simple subspherical cnidal knob, very different from that of the adult Discolabidæ. The development of this medusiform larva from the fertilised eggs of *Physophora magnifica* and its metamorphosis were observed by me in February 1867, in the Canary Island Lanzerote, and described in my Entwickelungsgeschichte der Siphonophoren (**84**, p. 17, Taf. i.–iv.).

The Challenger collection contained some larvæ of Discolabidæ very similar to these latter. The most remarkable are figured in Pl. XIX. figs. 5–8. Fig. 5 represents a very young Siphonula, the umbrella of which is nearly cap-shaped; the siphon possesses no tentacle, but some small buds of tentilla at its base. The larva, fig. 6, somewhat older, has a large bract with a canal, some buds of palpons, and a long tentacle, beset with a series of sessile cnidal knobs. These are replaced in the older larva, fig. 7, by pediculate spherical cnidonodes, or larval tentilla; the ventral cleft of the bract is much

deeper, the palpons larger; a pedicular canal (*cp*) passes from the bracteal canal to the exumbrella (compare **84**, p. 100, Taf. ii. figs. 17–22, *y*).

The most remarkable larva, however, is the Physonula figured in Pl. XIX. fig. 8; it was very well preserved in a preparation in the Challenger collection, taken at Station 325, in the South Atlantic (March 2, 1876; lat. 36° 44′ S., long. 46° 16′ W.), in the tow-net which had been down to a depth of 2650 fathoms. The nectosome was composed of an apical pyriform pneumatophore (*p*) and two opposite nectophores (similar to *Dicymba*, Pl. XVIII. fig. 1). The siphosome consisted of a large spindle-shaped siphon (*s*), with a simple cylindrical tentacle (*t*), and a basal corona of about a dozen slender palpons (*q*), each provided with a thin and long palpacle (*r*). The trunk of the nectosome in this monogastric larva was apparently the thin pedicle of the siphon itself (*am*); its apex bore the pneumatophore, as the modified original umbrella of the primary medusome.

Synopsis of the Genera of Discolabidæ.

Nectosome biserial, with two opposite rows of nectophores, ...	55. *Physophora.*
Nectosome quadriserial, with four cruciate rows of nectophores, ...	56. *Discolabe.*
Nectosome multiserial, with several continuous spiral rows of nectophores, . .	57. *Stephanospira.*

Genus 55. *Physophora*,[1] Forskål, 1775.

Physophora, Forskål, **11**, Descript., &c., p. 119.

Definition.—Discolabidæ with a biserial nectosome, composed of two opposite rows of nectophores. (Siphosome with a double corona of palpons.)

The genus *Physophora*, as one of the oldest known Siphonophoræ, was founded in 1775 by Forskål, who distinguished three species of it (**11**, p. 119). The first of these, *Physophora hydrostatica*, has been retained by later authors as the true type of the genus, whilst the two others belong to different genera, *Athorybia* (*rosacea*) and *Rhizophysa* (*filiformis*). Péron and Lesueur figured, in 1807, an Atlantic species under the name *Physophora myzonema* (**14**, pl. xxix. fig. 4). Quoy and Gaimard published, in 1833, an incomplete description of four species of *Physophora*; they seem to belong to four different genera (*Physophora australis, Discolabe discoidea, Circalia alba, Sphyrophysa intermedia*). Lesson distinguished no less than eight species (**3**, p. 503). The first accurate anatomical description of the typical Mediterranean *Physophora hydrostatica* was given in 1853 by Kölliker (**4**), and Vogt (**6**), afterwards completed by Leuckart (**8**), Huxley (**9**), Gegenbaur (**10**), and Claus (**34**, **74**). The ontogeny of *Physophora*, and its peculiar metamorphosis, were described by myself in 1869, as observed in a new splendid Atlantic form, which I called *Physophora magnifica* (**84**, Taf. i.–v.). A very careful

[1] *Physophora* = Bearing a vesicle, *φυσόφορα*.

description of a North Atlantic species, *Physophora borealis*, was published in 1877 by Sars (**27**, Heft iii. Taf. v., vi.). At present it is not possible to distinguish exactly the different species of *Physophora* described by numerous authors; a far more accurate anatomical description of the various parts and their arrangement, and a comparison of good figures drawn from nature, is indispensable to render specific distinction possible. Since the genus is not rare, and widely distributed over all seas, it is probably represented by numerous "geographical species."

Genus 56. *Discolabe*,[1] Eschscholtz, 1829 (*s. str.*).

Discolabe, Esch., System der Acalephen, p. 155.

Definition.—Discolabidæ with a quadriserial nectosome, composed of four cruciate rows of nectophores. (Siphosome with a single corona of palpons.)

The genus *Discolabe* was established in 1829 by Eschscholtz for a Mediterranean Physonect, which was described and figured very incompletely by Quoy and Gaimard under the name *Rhizophysa discoidea* (**20**, Isis, Bd. xxi. Taf. iv. fig. 7). The same authors called it afterwards *Physophora discoidea* (**2**, p. 59, pl. i. figs. 21–24). No doubt this Mediterranean form represents some Physophorid or Discolabid, the nectophores of which were detached from the stem; probably either *Physophora hydrostatica* (Forskål, **11**, p. 119) or *Physophora tetrasticha* (Philippi, **72**). This latter possesses four cruciate rows of nectophores and differs generically from the former (with two opposite rows of nectophores). *Physophora tetrasticha* may, therefore, retain the name *Discolabe mediterranea*, given by Eschscholtz. Another closely allied species, taken in the North Atlantic (in the Gulf Stream), may be called *Discolabe tetrasticha*. A third species, *Discolabe quadrigata*, inhabits the Indian Ocean, and was observed living by me during my residence in Belligemma, in December 1881. It is described in the following pages, and figured in Pls. XIX. and XX. Some incomplete but well-preserved corms, taken in the Indian Ocean, which I received from Captain Rabbe (of Bremen), seem to belong to the same species.

Discolabe quadrigata, n. sp. (Pls. XIX., XX.).

Habitat.—Indian Ocean, Ceylon (Belligemma), December 1881 (Haeckel).

Nectosome (figs. 1–4).—The swimming apparatus has the form of a slender tetragonal pyramid, which is twice as high as broad; its height is 40 mm., the basal breadth 20 mm. It is composed of an ovate apical pneumatophore, and of four longitudinal rows of nectophores, which are arranged around the axial trunk in a læotropic spiral. Each

[1] *Discolabe* = Discoidal noose or spiral, δίσκος, λαβή.

row has five or six developed nectophores, besides some young buds at the apical blastocrene, below the pneumatophore. Their total number, therefore, is twenty to twenty-four. Their size increases gradually from the top towards the base of the nectosome; the lowermost are the largest. The transverse section of the nectosome, or the apical view (fig. 15), exhibits a cross composed of four nectophores, lying in different horizontal planes according to the spiral twisting of their line of insertion. This læotropic spiral line is the ventral median line of the trunk. When the nectophores are detached from the trunk (figs. 9–13), this latter (*an*) appears as a spindle-shaped bladder about four times as long as thick, and tapering towards the two constricted ends; in its ventral median line arises a thin membranous vertical lamella, the mesentery of the nectosome, which bears the contracted pedicles of the detached nectophores (*np*).

Pneumatophore (figs. 1, 9–13, *p*).—The apical float is ovate, 10 mm. long and 5 mm. broad, with a pink octoradial pigment-star at the top. Eight equidistant meridian lines connect the two poles of its vertical axis, and are visible outside, as very delicate threads in the upper, and broad bands in the lower half. These lines are the insertions of eight meridian ribs on the inside of the pneumatocodon, which connect it in the lower half with the pneumatosaccus, and so form eight radial pouches. The breadth of the vertical radial septa separating the latter is effected by eight apophyses of the exodermal pneumadenia, extending in the fulcrum of the septa, which are covered by entoderm.

Nectophores (figs. 1 and 4, basal view; fig. 2, lateral view, from the right side; fig. 3, dorsal view).—The bilaterally symmetrical umbrella of the largest nectophores is twice as long and broad as thick; its principal axis (directed obliquely from above and inside downwards and outwards) is 12 mm. in length, and the frontal axis the same, whilst the sagittal axis is only 6 mm. In the median line of the concave ventral side arises the lamellar pedicle (fig. 2, *np*), the superior apex of which attaches the nectophore to the ventral mesentery of the trunk. The ventral edge of this pedicle fits into a corresponding median groove in the dorsal side of the subjacent nectophore. Seen from the base (figs. 1, 4), the outline of the nectophore is nearly rectangular, with a deep furrow in each side. The proximal half of the nectophore is much broader than the distal half, and dilated in the form of two ovate lateral lobes or auricles (fig. 3). To these correspond two shorter triangular basal lobes, which arise from the ventral side of the ostium of the umbrella.

Nectosac (figs. 1–4, *w*).—The muscular subumbrella of the nectophores is relatively large, since their jelly umbrella is rather thin-walled; the form of the latter is determined originally by the development of the former. The nectosac is composed of three different parts, which have an irregular ovate form; an odd median part and two paired lateral lobes in the proximal half. The nectocalycine duct, which passes through the pedicle of the umbrella, enters into the ventral side of the nectosac below its top. It divides into four radial canals of very different shape, two odd sagittal and two paired lateral.

The two former run simply curved in the median plane of the nectosac; the ventral is shorter than the dorsal. The two symmetrical lateral canals are much longer, each about three or four times as long as each of the sagittal canals; they pass into the two large lateral lobes of the nectophores, where they form half a dozen loops; their complicated course will be intelligible by comparison of figs. 2, 3, and 4. The small ring-canal which unites the equidistant distal ends of the four radial canals is elliptical and lies above the insertion of the velum (fig. 4, *cc*).

Siphosome (Pl. XX. fig. 9, apical view, from above; fig. 12, basal view, from below; figs. 10, 11, 13, ventral and half-lateral view, in different states; all the figures twice natural size. In Pl. XIX. fig. 1, the trunk of the siphosome is completely covered and hidden by the cormidia).—The trunk of the siphosome is a large reniform bladder, or an inflated disc of rose colour, subhorizontally expanded and depressed in a vertical direction; its breadth (30 mm.) is about twice as great as its height (15 mm.). The wide cavity of the thin-walled bladder is closed, filled with chyle, or the fluid of the gastrocanal-system, and communicates only at its apex with the base of the trunk of the nectosome, and by a peripheral corona of numerous small pores with the cavities of the cormidia. A comparison of figs. 9–13 in Pl. XX. demonstrates that the kidney-shaped and spirally twisted disc, from which the name *Discolabe* is derived, is nothing other than the inflated trunk of the siphosome twisted up in a low and broad spiral; the turning of the spiral is dexiotropic (delta-spiral), opposite to that of the trunk of the nectosome, the nectophores of which are arranged læotropically (lambda-spiral). The trunk of the siphosome in *Physophora* is described erroneously as a lambda-spiral by Claus (**74**, p. 13, Taf. iii. figs. 1–4). The spiral of the latter is also dexiotropic, but flatter and less developed than in *Discolabe;* in the largest specimens of the latter two complete turns may be distinguished (fig. 12). The superior or proximal face of the discoidal bladder is covered in the living animal by the base of the nectosome, the inferior or distal face by the axial parts of the cormidia, whilst the abaxial parts of the latter form a splendid corona around its peripheral margin.

Cormidia.—The number of ordinate cormidia covering the trunk of the siphosome is in the smaller specimens of *Discolabe* ten to twenty, in the larger thirty to fifty or more, besides the numerous small buds of undeveloped cormidia which arise from the blastocrene or the point of vegetation situated at the top of the siphosome. Beginning from this point, the age of the succeeding cormidia increases gradually, so that the lowermost (at the distal end of the trunk) are the oldest. These, however, are not the largest; the size of the cormidia is the greatest in the middle of the spiral series, and decreases towards the two ends of it. The peripheral margin of the spiral bladder, to which the articulated series of the ordinate cormidia is attached, is the ventral median line of the trunk of the siphosome. It appears elegantly facetted and regularly segmented after the detachment of the covering corona of palpons; the size of these polygonal articular facettes, the largest of which are

4 to 5 mm. in diameter, decreases also towards the two ends of the spiral, according to that of the inserted cormidia. Each single cormidium (Pl. XX. fig. 16) is composed of the following parts, which succeed one another in the distal direction, beginning from the uppermost part of the facette:—(1) a simple palpacle (*r*); (2) a large palpon (*p*); (3) a female gonodendron (*gf*); (4) a male gonostyle (*gh*); (5) a tentacle (*t*); and (6) a siphon (*s*). Since the tentacle is only an organ of the siphon, and the palpacle an organ of the palpon, each cormidium may be explained as originally an association of four medusomes, two fertile and two sterile; the umbrellas belonging to the latter may have been originally the nectophores, widely dislocated and separated. The common base of the trunk from which these parts of each cormidium arise, corresponds to a node or a lateral branch of those Siphonanthæ which have prolonged stems with large internodes and widely distant ordinate cormidia. The muscular frame which surrounds each polygonal facette corresponds to the muscle-group of the internode. The facette itself, which becomes visible after the detachment of the palpons, above the gonodendra, is the base of their insertion, with the palponal canal in the centre (figs. 9–13, *cq*).

Siphons (Pl. XIX. fig. 1; Pl. XX. figs. 13, 16, *s*).—The single siphon of each cormidium is inserted into its distal side or the inferior part of the node of the trunk; this is the innermost part in the subhorizontally coiled-up trunk, on the concave inside of the spiral bladder. When the siphons are detached from their pedicles, and the trunk seen from below (Pl. XX. fig. 12), the conical papilliform pedicles remaining connected with the trunk form a regular dexiotropic spiral line on its basal face (fig. 12, *sp*). The siphon proper, besides the pedicle, is spindle-shaped or ovate, and has in the dilated state a length of 20 or 30 mm. or more, in the contracted state scarcely 4 to 8 mm. Its basigaster is ovate, large, the thick-walled exoderm full of small cnidocysts. The dilated stomach is rather thin-walled, inside covered with vacuolated villi, without coloured hepatic stripes. The contractile proboscis is very dilatable, with eight strong longitudinal muscle-bands. The distal mouth may be expanded in the form of a large suctorial disc, and is sometimes circular, at other times slightly octolobate (figs. 13, 16, *so*).

Tentacles (Pl. XIX. fig. 1; Pl. XX. figs. 13–16, *t*).—The long capturing filament, which arises from the pedicle of each siphon, near the attachment of its basigaster, bears a series of very numerous large tentilla. Each fully-developed tentillum exhibits the peculiar well-known structure of *Physophora*, and is composed of two parts, a long pedicle, the distal portion of which is inflated, and a large pyriform cnidosac (fig. 14). This latter contains, included in a double involucre, a very large, spirally coiled up and reflected pink cnidoband. The two lateral groups of large ensiform cnidocysts, which were originally placed on the proximal end of the cnidoband, lie in the fully-developed tentillum on its distal end; this remarkable inversion is effected by the peculiar development of the involucre described above (p. 260). The proximal base of the involucre is connected in the median line of its concave ventral side with the distal end of the reflected

cnidoband, and here are visible in younger tentilla the rudiments of the tripartite terminal filament. This has disappeared in the adult tentillum (fig. 14). The cnidosac of this latter is convex on the dorsal, concave on the ventral side, and bearsnear its middle zone a pair of lateral purple pigment-rings, like ocelli, similar to those which I have described in *Physophora magnifica* (84, pl. iv. fig. 28). These ocelli (fig. 14, *ty*), like the similar ocellar spots of many other animals, are probably protective ornaments discouraging and frightening the attacking enemies.

Palpons (Pl. XIX. fig. 1, *q*; Pl. XX. fig. 16, *q*).—Immediately beyond the nectosome is expanded the large corona of palpons, which arises from the top of the siphosome. This corona is simple in *Discolabe* (as also in *Stephanospira*), whilst it is double in *Physophora*. Each cormidium bears only a single taster, attached to its uppermost or proximal part. It is rose coloured, violet towards the apex. The fully-expanded palpon is a thick-walled, very firm, cylindrical or spindle-shaped tube 30 to 40 mm. in length and 6 to 8 mm. in breadth; in the contracted state it is scarcely half as long, and pyriform. The thick muscular wall is supported by a strong cartilaginous fulcrum and surrounds a wide cavity, which is closed at the pointed distal end; this is provided with a corona of twenty to thirty very large cnidocysts, the protruded cnidofilament of which is more than 1 mm. in length. The proximal base of the palpon is obliquely truncated and apposed to the articular facette of the trunk by a very small pedicle. The narrow canal of the pedicle, which connects the wide cavities of the trunk and the palpon, is visible after the detachment of the latter as a small pore in the centre of the facette (figs. 9–13, *cq*).

Palpacles (Pl. XIX. fig. 1, *r*).—Each palpon bears attached to its proximal base, in the middle of its upper face, a very long and thin tasting filament. It may be extended to a length which surpasses that of the palpons three or four times or more. The thin wall of the cylindrical tubule is distinctly segmented, with very numerous equidistant annular constrictions (Pl. XX. fig. 16, *r*).

Gonostyles (Pl. XX. figs. 9–16, *g*).—Each cormidium possesses two gonostyles, arising from the periphery of the vesicular trunk, one very near to the other, between siphon and palpon. The female gonostyle is an ovate, richly branched bunch (*gf*), composed of many hundred small gynophores. These are subspherical, pediculate, and contain a single ovum only. The male gonostyle is very different in form, not branched, but a long cylindrical tube with wide cavity and thin muscular wall, which can be widely extended or strongly contracted. The surface of this gonopalpon (*gq*) is covered with numerous oblongish, spindle-shaped, or subcylindrical androphores, the size and age of which increases from the proximal towards the tapering distal end. When the ripe androphores in the latter are detached, their short pedicles remain as small hemispherical papillæ. Older gonostyles bear only a few androphores at their proximal base, while the greater part of the naked tube hangs down like a papillate tentacle (fig. 16, *hp*). The ripe androphore is about four times as long as broad, and much larger than the ripe gynophore.

Genus 57. *Stephanospira*,[1] Gegenbaur, 1859.

Stephanospira, Gegenbaur, Neue Beiträge, &c., **10**, p. 67, figs. 53–58.

Definition.—Discolabidæ with a multiserial nectosome, composed of several rows of nectophores spirally arranged. (Siphosome with a single corona of palpons.)

The genus *Stephanospira* was established in 1859 by Gegenbaur for a Physophorid of unknown origin, of which he could only examine a single incomplete specimen, preserved in alcohol; the nectophores as well as the siphons and palpons were detached and lost; the trunk only was preserved, with the pneumatophore at the apex and the corona of gonodendra in the periphery of the siphosome. It is, therefore, easy to explain that the description of Gegenbaur contained some errors, and that he supposed it to be a widely aberrant type of Physophoridæ. Sars has since corrected those errors, and made it probable that *Stephanospira* may be only a mutilated specimen of *Physophora* (**27**, Heft iii. p. 42). The same opinion is supported by Claus (**74**, p. 16, &c.). Indeed, it may be that this opinion is right, and in any case *Stephanospira* belongs to our family Discolabidæ. But the incomplete state of the single specimen examined, which it is impossible to identify, and mainly the entire absence of nectophores, leaves open the question, whether these were arranged originally in two opposite, four cruciate, or numerous spiral rows. Having recently seen an excellent picture by Mr. Wild, taken from life, representing an Atlantic *Physophora*, the conical nectosome of which is similar to that of *Forskalia* and composed of numerous nectophores spirally arranged, I retain for this form the name *Stephanospira*. I shall publish the description and figures of this *Stephanospira corona* in my Morphology of the Siphonophoræ. In form the vesicular spiral trunk and the distinctly ordinate monoclinic pairs of gonodendra are similar to those of *Stephanospira insignis*, Gegenbaur.

Family XVII. Anthophysidæ, Brandt, 1835.

Anthophysidæ, Brandt, 1835, Prodromus, &c., **25**, p. 35.
Athorybidæ, Huxley, 1859, **9**, pp. 71, 85.

Definition.—Physonectæ polygastricæ, with a short vesicular stem of the siphosome, bearing numerous siphons and palpons, each siphon provided with a branched tentacle. Nectosome without nectophores, but with a corona of bracts. Pneumatophore with radial pouches.

The family Anthophysidæ of Brandt (1835), identical with the Athorybidæ of Huxley (1859), differs from all the other Physonectæ polygastricæ in the absence of nectophores, which are replaced by a corona of bracts. It agrees in this striking

[1] *Stephanospira* = Spiral corona, στέφανος, σπεῖρα.

character with the monogastric Athoridæ, but differs from this closely allied family in the possession of numerous siphons.

The first described and the best known type of Anthophysidæ is the Mediterranean *Athorybia rosacea*. It was discovered by Forskål, who figured it under the name *Physophora rosacea* as early as 1775 (**11**, Tab. xliii. fig. B). Two other closely related species, taken in the Strait of Gibraltar, were described by Quoy and Gaimard as *Rhizophysa heliantha* and *Rhizophysa melo* (**20**), and afterwards placed by the same authors in the genus *Stephanomia* (**2**). These three species together were united in the genus *Athorybia* by Eschscholtz (**1**, p. 153) in 1829. A similar fourth form, taken in the Northern Pacific, was described by Mertens as *Anthophysa rosea* (**25**, p. 36), and Brandt in 1835 established for all these together the family Anthophysidæ.

The first accurate anatomical description of *Athorybia* was published in 1853 by Kölliker (**4**, Taf. vii.), and supplemented by Huxley in 1859 (**9**, pl. ix.). He called the family represented by it Athorybidæ. The genus *Anthophysa* differs from the former in the possession of two kinds of tentacular knobs. An American species of this genus was afterwards accurately described by Fewkes, under the name *Athorybia formosa* (**44**, p. 271, pls. v., vi.). The development of the fertilised egg was examined in 1866 by myself (**84**, p. 88, Taf. xiv.).

The Anthophysidæ, or Athorybidæ, are among the most beautiful and most delicate Siphonophoræ. But they are in general rare, and owing to their small size and fragility their anatomical investigation is difficult. Some interesting new forms of this family, which I was able to examine living in the Mediterranean, the Atlantic, and the Indian Ocean, have enabled me to complete their anatomical knowledge (Pls. XI., XII.).

Truncus.—The cœnosome or common stem is in all Anthophysidæ a small ovate, pyriform, or flatly conical vesicle. Its apical (proximal or superior) half is the nectostyle, includes the pneumatocyst, and bears the corona of bracts; its basal (distal or inferior) half is the siphostyle, and bears in the periphery a corona of very numerous palpons, in the central part a smaller number of siphons, tentacles, and gonostyles.

Although the general appearance of the corm in all Anthophysidæ is radial, nevertheless the fundamental form of the trunk is always bilateral, as in all the other Siphonanthæ. The series of buds, which is visible as well in the nectosome (Pl. XII. fig. 9, *ib*) as in the siphosome (fig. 9, *is*), marks the ventral median line of the trunk.

Cormidia.—The numerous polymorphous persons or medusomes, which compose the corm of the Anthophysidæ, are arranged around the common central trunk in a certain regular manner. This has hitherto escaped all observers, owing to the small size and the great delicacy of the object. The specimen of *Anthophysa darwinii*, which I found in the Challenger collection, and which is figured in Pl. XII. figs. 7–9, exhibited this regular arrangement of the cormidia more distinctly than the smaller species of *Athorybia* hitherto described. In general this ordinate structure seems to be

similar to that of *Physophora* and the other Discolabidæ, the cormidia being ordinate and arranged symmetrically in a flat spiral line, which is twisted around the flat and broad base of the shortened vesicular stem. (Compare Pl. XII. figs. 7–9 ; fig. 7, dorsal view ; fig. 8, lateral view, from the left side ; fig. 9, ventral view.)

The ventral view (fig. 9) exhibits at once the bilateral form of the corm, which is bisected in the ventral median line by the series of buds ; these develop from two separate blastocrenes (springs of buds, or "puncta vegetationis"). The superior blastocrene (*ib*) is the point of development of the nectosome (bracts), and from it radiate bilaterally the ridges which bear the pedicles of the bracts. Each convex ridge is composed of four finer parallel ribs ; these are straight and horizontal in the uppermost and oldest ridges, undulating and vertical in the youngest and lowermost ridges. There are five or six quadripartite ridges on each side of the trunk of the nectosome, divergent from the ventral towards the dorsal side, where the large ovate pneumatophore arises. The inferior blastocrene (fig. 9, *is*) is the punctum vegetationis of the siphosome ; its numerous buds, densely crowded in the lower half of the ventral median line, become so developed and dislocated that the superior compose a corona of palpons (*q*), the inferior a basal corona of gonostyles (*g*) and alternating siphons (*s*) and tentacles (*t*). The arrangement of these parts in the lateral view of the corm, after removal of the majority of the palpons (fig. 8), seems to demonstrate that the cormidia, although densely crowded without interval, are nevertheless ordinate. Each cormidium seems to be composed of a large siphon, and the appertaining tentacle, of two gonodendra (a male and a female group of gonophores), and of a certain number of palpons. Further, each cormidium of the siphosome seems to belong to a corresponding quadripartite ridge of the nectosome, with four parallel ribs bearing a number of bracts (figs. 8, 9, *bp*).

Respecting the phylogenetic origin and development of this peculiar arrangement, we may assume that originally each ridge of the nectosome (with a group of bracts), and each cormidium of the siphosome, have arisen from a single medusome, the former from its umbrella, the latter from its manubrium ; both being widely dislocated afterwards. But in these ordinate cormidia of the Anthophysidæ, as well as in the similar ones of the Discolabidæ and Nectalidæ, a further comparative morphological study is required to solve the difficult question of their original composition.

Pneumatophore.—The float filled with air occupies the upper half of the cœnosome, and is usually ovate or ellipsoidal. Its uppermost part is sometimes prominent over the corona of bracts, at other times retracted and hidden between them. Its apex usually bears a pink or purple pigment-star with eight rays, composed of elegant polygonal exoderm cells (figs. 5–9). The centre of this star is usually colourless. The pneumatosaccus includes the thin-walled chitinous pneumatocyst. Its lower part is connected by a variable number of radial septa (usually eight or sixteen) with the pneumatocodon or the outer wall of the float (fig. 7, *p*).

Bracts (Pl. XI. figs. 1, 2; Pl. XII. figs. 14–16).—The hydrophyllia, or bracts, which make up the main part of the nectosome, form an elegant corona around the pneumatophore, similar to a double rose, or other flower with numerous petals. Their number is usually between twenty and forty, sometimes more than sixty. They are always thick sickle-shaped scales of a more or less elliptical or lanceolate outline, strongly curved, and attached to the stem by a short pedicle. Sometimes these pedicles are rather broad lamellæ, similar to the pedicles of the nectophores in the Rhodalidæ (Pl. XII. figs. 7–9, *bp*). The inner or axial face of the bract is concave and smooth, the outer or abaxial face convex and armed with a variable number of longitudinal ribs or crests, which bear a series of cnidocysts. The thick and firm jelly-substance of the cartilaginous bract encloses a simple canal or phyllocyst, which runs near the inner surface in the median line, and ends blindly at the distal end (fig. 14, *bc*).

No doubt the bracts of the Anthophysidæ are either parts of divided nectophores, or entire reduced nectophores which have lost the nectosac with the subumbrella and the four radial canals, but developed more strongly the jelly-substance of the umbrella, forming a firm protecting scale, or a "cartilaginous shield." The bracts of *Rhodophysa* still possess a small rudimentary nectosac at the distal end, similar to that of *Athoria*, and of the Athorula larvæ of many Physonectæ (Pl. XXI. figs. 5–12). The arrangement of the bracts in a simple corona, or in several concentric closely apposed circles (one over the other), is very similar to that exhibited by the simple or multiple corona of nectophores in the Rhodalidæ (Auronectæ). As in these latter, the apparent radial arrangement is at the same time bilateral, since the series of buds in the median ventral line (Pl. XII. figs. 7–9, *ib*) bisects the corona into two symmetrical halves. The corona of bracts in *Anthophysa* (Pl. XII. fig. 7, from the dorsal; fig. 8, from the left; fig. 9, from the ventral side) is distinguished by the peculiar bilateral arrangement of the arched ribs of the nectosome, which bear the pedicles of bracts (*bp*). Each ridge is composed of four parallel finer ribs; therefore four bracts are associated in a smaller group. This quadripartite structure may be perhaps explained by the supposition, that each bract is originally the quadrant of a quadripartite umbrella; the more so as the number of bracts is about four times as great as the number of siphons (the dislocated manubria?).

The bracts are organs of protection as well as of locomotion. They cannot change their form; but they can be elevated and depressed by means of a pedicular muscle, which is attached to their basal pedicle. When freely swimming at the surface of the tranquil sea, the corona of bracts is alternately closed and opened by slowly elevating and depressing the single bracts; the water protruded from the cavity surrounded by the bracteal corona (and comparable physiologically to the swimming cavity of Medusæ) propels the body in the apical direction, the pneumatophore forwards. But when the animal is alarmed the bracts are contracted closely together and surround a subspherical, nearly closed cavity, in which the retracted palpons, siphons, tentacles, and gonodendra are hidden.

Palpons (Pl. XI. figs. 1, *q*, 2, 4; Pl. XII. figs. 7–9, *q*).—The tasters of the Anthophysidæ form a simple or multiple corona beyond that of the bracts; their number is very large but variable, and seems to correspond usually to that of the latter; it is possible that originally one taster belonged to each single bract, both together composing a medusome (?). The palpon in this case would be the manubrium, and the bract the appertaining umbrella of the medusome. The arrangement of the tasters, too, in the larger Anthophysidæ, is very similar to that of the bracts, and the corona of both is bisected by the series of buds (fig. 9, *is*) placed in the median line of the ventral side.

The tasters are very long and thin, cylindrical or spindle-shaped tubules, widely protruding through the spaces left between the adjacent bracts when the latter are expanded (Pl. XI. fig. 1). They are very mobile and flexible, tasting like feelers on all sides. The proximal end of their simple cavity opens into the common stem-cavity, whilst the distal end is closed, and usually armed with a corona of large radial cnidocysts (fig. 4, *qc*). Sometimes a pigment-spot is visible at the lower side of the distal end, and in *Athorybia ocellata* this eye-spot seems to surround a small lens or refracting body; it may be perhaps an ocellus (fig. 4, *qo*). When contracted, the palpons appear as spindle-shaped or ovate vesicles, hidden in the cavity surrounded by the corona of bracts. There are no palpacles or tasting filaments at the base of the palpons.

Siphons (Pl. XI. figs. 1, *s*, 3; Pl. XII. figs. 7–9, *s*, fig. 10, longitudinal section).—The number of polypites or siphons in the Anthophysidæ is always much smaller than that of the palpons and bracts; usually the number of the latter may be four to six times as great as that of the former. The smaller species of Anthophysidæ have usually only three to six, the larger eight to twelve siphons. These occupy the basal part of the trunk, beyond and inside the corona of palpons, which are much smaller in size. The usual four segments in the body of the siphon are very distinct (figs. 3, 10, longitudinal section). The short pedicle (*sp*) opens by a narrow canal into the cavity of the trunk. The basigaster (*sb*) is very large and thick-walled, usually of a yellowish or reddish colour; the exoderm is much thickened and filled with innumerable cnidocysts. The true stomach (*sm*) is ellipsoidal, ovate or subspherical, and has a thin exoderm; but the entoderm-wall is very thick and protrudes inside in the form of numerous conical villi, which contain a variable number of vacuoles or glandular spaces (fig. 10, *sv*). The proboscis (*sr*) is very large and extensile; in the contracted state (fig. 10, *sr*), its muscular wall is very thick, and the entoderm composed of high cylindrical epithelial cells; sometimes six or eight longitudinal ribs are visible (fig. 3, *sr*). The terminal mouth may be expanded in form of a large, delicate, polygonal suctorial disc, usually with six or eight triangular lobes (fig. 1, *ss*).

Tentacles (Pl. XI. fig. 1; Pl. XII. figs. 11–13).—Each siphon is provided at its base with a long tubular tentacle, which bears a series of tentilla or lateral branches. The form and composition of these tentilla exhibits in the different genera of Anthophysidæ

differences similar to those in the Agalmidæ. The cnidonode of the tentillum includes a spiral band with a few turnings; the cnidobattery of this band is composed of very numerous small median cnidocysts and two opposite lateral rows of large spindle-shaped cnidocysts. It bears a simple terminal filament in the two genera *Rhodophysa* and *Melophysa*, whilst it is trifid in the two genera *Athorybia* and *Anthophysa*, divided into a median terminal vesicle and two paired lateral horns; usually these are coiled up spirally (Pl. XII. figs. 11–13). The distal part of the cnidonode is prolonged commonly on the dorsal side into a conical apophysis or a solid pointed spur, composed of large hyaline entoderm cells. Besides, the genus *Anthophysa* is distinguished by the possession of a second, larger and rarer, kind of cnidonode, differing from the former in the development of two paired, dendritic or palmate apophyses on the dorsal side of the cnidosac.

Gonostyles.—Each cormidium of the siphosome (probably in all Anthophysidæ) is monoclinic and bears two gonodendra, a male and a female, attached to the base of the trunk, near to the insertion of the appertaining siphon. Sometimes the two branched gonostyles arise separately, each with a proper pedicle (Pl. XII. fig. 17, *gp*, male; fig. 18, *gp*, female); at other times both arise from a common pedicle, which also bears some small palpons or sexual hydrocysts (9, pl. ix. fig. 12). The gonophores arise clustered in variable number from the branches of the dendritic gonostyles; the males are usually coloured (reddish or white), the females colourless.

The androphores, or the male medusiform gonophores (fig. 17, *h*), have an oblong, club-shaped or even cylindrical umbrella, the narrow distal mouth of which is surrounded by a small velum; above this lies a small circular canal, which unites the four radial canals. The spermarium (*hs*) is a long spindle-shaped or cylindrical manubrium, with a central spadix (*hx*); it fills up the subumbrellar cavity and is often protruded from it.

The gynophores, or the female medusoid gonophores (fig. 18, *f*), develop only a single large ovule in the wall of the manubrium, and the central canal of the latter, growing around the surface of the ovule, and partly obliterating, forms a network of irregular spadicine canals, not to be confounded with the four radial canals of the embracing umbrella.

Synopsis of the Genera of Anthophysidæ.

Tentilla with a simple (naked or involucrate) cnidoband and a single terminal filament.	Bracts with a rudimentary nectosac at the distal end. Cnidoband naked, .	58. *Rhodophysa.*
	Bracts without nectosac. Cnidoband involucrate, ...	59. *Melophysa.*
Tentilla with an involucrate cnidoband and three to five terminal appendages. Bracts without nectosac.	All tentilla of the same form, tricornuate. Cnidosac without dendritic apophyses, .	60. *Athorybia.*
	Tentilla tricornuate, of two different forms; the larger with two dendritic apophyses of the cnidosac, . . .	61. *Anthophysa.*

Genus 58. *Rhodophysa*,[1] Blainville, 1834.

Rhodophysa, Blainville, Actinologie, p. 123 (*sensu mutato*).

Definition.—Anthophysidæ with a rudimentary nectosac at the distal end of the bracts. Cnidonodes of the tentacles simple, without involucre, with a naked cnidoband and a single terminal filament.

The genus *Rhodophysa* was constituted by Blainville (**24**) for the reception of the same three forms of Physonectæ which Eschscholtz had united five years before in his genus *Athorybia*. This latter name therefore has the right of priority. Retaining here the name *Rhodophysa*, I employ it for those interesting, hitherto undescribed, forms of Athorybidæ, which differ from the others in the possession of a small rudimentary nectosac at the distal end of the bracts. This structure is the same as is found in *Athoria* among the monogastric Athoridæ (p. 201, Pl. XXI. figs. 5–10), and in the similar Athorula-larvæ of some Physonectæ (p. 200). It is of great morphological interest, as a proof that the bracts in this case are reduced nectophores.

A single specimen of *Rhodophysa* was observed by me in the Indian Ocean during my voyage from Ceylon to Aden (between the Maldive Islands and Socotra) in March 1882. It was in general very similar to the well-known Mediterranean *Athorybia rosacea*, being also of the same light rose-colour, but differed in two essential points. Each bract exhibited at the distal end a small rudiment of a nectosac, similar to that of *Athoria larvalis* (Pl. XXI. figs. 5–10). Further, the tentilla possessed a naked spiral cnidotænia, with a single terminal filament, similar to the tentilla of *Athoria* and *Forskalia* (Pl. X. fig. 23). Unfortunately the single specimen of this remarkable *Rhodophysa corona* was destroyed before I could make a representation of it. It requires further examination.

Genus 59. *Melophysa*,[2] Haeckel, 1888.

Melophysa, Hkl., System der Siphonophoren, p. 42.

Definition.—Anthophysidæ with simple bracts, without nectosac. Cnidonodes of the tentacles simple, with an involucre and a single terminal filament.

The genus *Melophysa* comprises those Anthophysidæ which have the general structure of the typical *Athorybia*, but differ from it in the singular form of the tentilla, or the cnidal knobs of the tentacles. Each tentillum bears a simple spiral cnidotænia, the basal half of which is enveloped by an involucre, and at its distal end a simple terminal filament; it is therefore similar to the tentilla of *Stephanomia* (**9**, pl. vi. fig. 8). Respecting this difference, *Melophysa* exhibits a relation to *Athorybia* similar to that which *Stephanomia* bears to *Crystallodes*, or *Halistemma* to *Agalmopsis*.

[1] *Rhodophysa* = Rose-bladder, *ῥόδον*, *φῦσα*.

[2] *Melophysa* = Melon-vesicle, *μῆλον*, *φῦσα*.

During my residence in the Straits of Gibraltar, in March 1867, I once encountered a small elegant Anthophysid, which at first glance I supposed to be a species of *Athorybia*. A closer examination, however, demonstrated that the form of the tentilla was quite different, each spiral cnidotænia being half enveloped by a campanulate involucre and ending with a single terminal filament (as in *Anthemodes*, Pl. XV.). The form of the bracts was very similar to that figured in *Athorybia melo*, which Quoy and Gaimard had observed in the Strait of Gibraltar forty years before (**2**, pl. ii. figs. 7–12). It is possible that these two forms are identical. The single specimen of *Melophysa melo* captured was lost before I could make a drawing of it.

Genus 60. *Athorybia*,[1] Eschscholtz, 1829.

Athorybia, Esch., System der Acalephen, p. 153.

Definition.—Anthophysidæ with simple bracts, without nectosac. Cnidonodes of the tentacles involucrate, trifid, with a median terminal vesicle and two lateral horns.

The genus *Athorybia*, the oldest and best known form of Anthophysidæ, was founded by Eschscholtz for the reception of three closely allied species; the typical Mediterranean form described in 1775 by Forskål (**11**) as *Physophora rosacea*, and two species observed in the Strait of Gibraltar by Quoy and Gaimard, and named *Rhizophysa heliantha* and *Rhizophysa melo* (**20**). An accurate anatomical description of the Mediterranean *Athorybia rosacea* was first given in 1853 by Kölliker (**4**, p. 24, Taf. vii.). *Athorybia heliantha* from the Northern Atlantic seems to be closely allied to it; it differs, however, in the special form of the tentilla described by Gegenbaur (**10**, p. 82, Taf. xxxi. figs. 43, 44). Another form of tentilla is exhibited in the Canarian *Athorybia ocellata* described in the sequel, differing also from the former species the form of the bracts and the possession of ocelli on the palpons. Another species, distinguished by the form of the bracts as well as that of the cnidosacs, is *Athorybia indica*, discovered by Huxley in the Indian Ocean and described under the name *Athorybia rosacea* (**9**, p. 86, pl. ix.). The gonodendra of this species are monostylic, while usually they are distylic. A number of different species of this genus seem to inhabit all warmer seas; they are, however, in general rare, and an accurate description illustrated by figures taken from the living animals is required to render their comparison and specific distinction possible. Special attention must be paid to the bilateral structure of the vesicular trunk, its ventral series of buds (Pl. XII. fig. 9, *ib*, *is*), and the relation of the nectostyle to the siphostyle. In some species of *Athorybia* the retracted pneumatophore is covered on its ventral side by the prominent cucullate nectostyle, as in *Anthophysa* (Pl. XII. figs. 7–9).

[1] *Athorybia* = Pacific, ἀθορυβίας.

Athorybia ocellata, n. sp. (Pl. XI.; Pl. XII. figs. 10–18).

Habitat.—North Atlantic, Canary Islands (Lanzerote); January and February 1867 (Haeckel).

Corm (Pl. XI. fig. 1, lateral view; fig. 2, apical view).—The complete body of the elegant corm is in the contracted state, with retracted organs, nearly spherical, 10 to 12 mm. in diameter. In the expanded state, with distant bracts and elongated organs, it has the appearance of a rose or other double flower. The numerous palpons are then protruded between the distant bracts, and the siphons and tentacles more or less prominent. The colour of the entire corm is slightly roseate, the bracts somewhat bluish, the float purple, the centre yellow.

Truncus.—The common central stem is an ovate or slightly conical vesicle, 6 to 9 mm. in diameter. Its upper pointed part is the nectostyle, includes the pneumatocyst, and is surrounded by the corona of bracts. Its broader lower part is the siphostyle, and bears a corona of numerous slender palpons, and beyond these, in the central part of the base, four to eight large siphons, each provided with a tentacle and surrounded by two gonodendra, a male and a female. The conical top of the nectostyle (Pl. XI. fig. 1, *ib*) embraces sometimes the ventral side of the retracted pneumatophore (*p*) like a cowl, and the apex of the former is prominent over that of the latter.

Pneumatophore (figs. 1, *p*, and 5, lateral view; figs. 2 and 6, apical view).—The pneumatosaccus, which is formed by the invaginated upper half of the conical nectostyle, includes an ovate or urn-shaped pneumatocyst (figs. 5, 6). Its apex is colourless, surrounded by a pigment-star with eight pink lanceolate rays. Its basal part exhibits eight radial pouches, separated by eight vertical septa of the pneumatophore. The retracted float may be hidden completely between the bracts.

Bracts (Pl. XI. figs. 1, 2; Pl. XII. figs. 14–16).—The bracts or covering scales, thirty to fifty in number, form an elegant corona around the pneumatophore. They are arranged in three or four circles, closely placed one over the other; these circles may be regarded as parts of a symmetrical corona, bisected by the ventral series of buds. The bracts are elliptical or lanceolate, 6 to 9 mm. long, 2 to 3 mm. broad, inside concave and smooth, outside convex and armed with a variable number of cnidal crests, usually eight. The exodermal epithelium of the outside is composed of large polygonal cells, and includes near the lateral margin a number of scattered large cnidocysts (fig. 15, *k*), and at the margin itself, as well as in the prominent ribs (fig. 16, *br*), patches of cnidocysts and dark pigment-granules. The simple canal of the bract runs along the median line of the inner concave face (fig. 14, *bc*), and ends blindly near to its apex. The jelly-substance of the bract is rather thick and firm.

Palpons (figs. 1, *q*, 2, 4).—The tasters are long and thin cylindrical, rose-coloured tubules; they seem to correspond in number and arrangement to the bracts, and are attached in a corona beyond the latter. When the corona of bracts is expanded (figs. 1, 2), the feelers are widely protruded through the clefts between them, tasting on all sides. The simple cavity of the thin-walled muscular palpons opens into the common stem cavity at the proximal end, whilst their distal end is closed and surrounded by a ring composed of larger thread-cells (fig. 4, *qe*). Somewhat above this ring is a pink pigment-spot placed at the lower side of the palpon; it may be regarded as an ocellus, since it is provided with a roundish refracting body, similar to a lens (fig. 4, *qo*).

Siphons (Pl. XI. figs. 1, *s*, 3; Pl. XII. fig. 10, longitudinal section).—The number of polypites is small, and did not exceed eight in the largest specimens observed; the smaller had only four or five. Their size is large; their colour rose. Their base is attached to the common stem beyond the corona of palpons. The short pedicle of each siphon (*sp*) bears a thick-walled basigaster (*sb*), the exoderm of which has a golden yellow colour and contains crowded masses of cnidocysts. The stomach (*sm*) exhibits inside numerous conical villi containing glandular bodies and vacuoles. The entoderm of the extensile proboscis is composed of high and slender cylindrical cells (fig. 10, *sr*). The distal mouth may be expanded in the form of a broad and delicate suctorial disc, which is sometimes distinctly polygonal, with six or eight short lobes (Pl. XI. fig. 1, *ss*).

Tentacles (Pl. XI. fig. 1).—To the pedicle of each siphon, close to its base, is attached a long tubular tentacle which bears a series of very numerous tentilla or lateral branches. Each tentillum (Pl. XII. fig. 11, from the ventral; fig. 12, from the dorsal; fig. 13, from the lateral, left side) bears upon a long pedicle (*ts*) an ovate cnidosac. The large cnidobattery contained in it has one and a half or two spiral turnings and is composed of innumerable small paliform cnidocysts, with a lateral row of large ensiform cnidocysts (*tk*) on each side. From the distal end of the cnidosac arise four terminal appendages, two odd sagittal and two paired lateral. The latter are two cylindrical filaments, usually coiled up spirally, like two frontal horns (*tc*). Between these arises from the ventral side an ovate thin-walled vesicle or terminal ampulla (*ta*), and opposite to this from the dorsal side a conical solid spur, composed of large clear entoderm-cells (*tz*).

Gonophores.—Each cormidium is monoclinic, and bears on separate stalks, attached to the trunk of the siphosome close to the base of the siphon, two gonodendra composed of clustered gonophores, a male (fig. 17) and a female (fig. 18). The male gonophores (*h*) are rose-coloured and more oblong, with a club-shaped spermarium (*hs*). The female gonophores (*f*) develop only a single egg in the manubrium. The umbrella has in both sexes four radial canals and a marginal ring-canal.

Genus 61. *Anthophysa*,[1] Mertens, 1829.

Anthophysa, Mertens, MS. (Russian Acad.); Brandt, Prodromus, &c., 1835, **25**, p. 35.

Definition.—Anthophysidæ with simple bracts, without nectosac. Cnidonodes of the tentacles involucrate, trifid, with a median terminal vesicle and two lateral horns; besides a part of the cnidonodes larger, with two dorsal dendritic apophyses.

The genus *Anthophysa* was established by Mertens in 1829 for a large and very interesting Anthophysid, which he observed living (May 12, 1828) in the Northern Pacific, north of the Bonin Islands (lat. 36° 30′ N., long. 214° 0′ W.). Brandt afterwards (in 1835) gave a short description of it (**25**, p. 35), and founded upon this genus and the closely allied *Athorybia* of Eschscholtz the family Anthophysidæ. The excellent figures of it executed by Mertens were never published, but I have examined them and compared them with his manuscript. According to this, the vesicular truncus is pyriform and rather large, similar to a small *Alophota* or a young *Physalia*, about two inches in diameter (30 mm. long and 20 mm. high). The purple pneumatophore is surrounded by a corona of numerous sickle-shaped bracts; and beyond these twelve siphons are visible, each provided with a long articulate tentacle.

The structure of the tentacles in this *Anthophysa rosea* (Mertens) seems to be similar to that of a North Atlantic species which Fewkes described in 1882 under the name *Athorybia formosa*.[2] This beautiful species differs from the true *Athorybia* in the possession of two kinds of cnidosacs on the tentacles, one of which is similar to that of the latter, the other distinguished by the addition of two dorsal dendritic apophyses.[3]

A third species of *Anthophysa*, which seems to be closely allied to the two preceding, was found by me in a bottle in the Challenger collection (from Station 334, South Atlantic), and although the only specimen was incomplete and not very well preserved, I will give its description in the following paragraphs.

Anthophysa darwinii, n. sp. (Pl. XII. figs. 7–9).

Habitat.—Southern Atlantic; Station 334, March 14, 1876; lat. 35° 45′ S., long. 18° 31′ W.; surface.

Corm (Pl. XII. fig. 7, dorsal view; fig. 8, lateral view from left side; fig. 9, ventral view).—The complete body of the corm in the spirit specimen which I examined and figured was well preserved, although strongly contracted by the influence of the alcohol. All the parts of the single organs were present, with the exception of the bracts, the majority of which were detached, a few only remaining (fig. 9, *b*). The entire corm had

[1] *Anthophysa* = Flower-shaped bladder, ἄνθος, φῦσα.

[2] *Bull. Mus. Comp. Zoöl.*, vol. ix. No. 7, p. 271, pl. v. figs. 3, 4; pl. vi. figs. 7–14.

[3] *Loc. cit.*, pl. vi. figs. 7, 8.

on the whole a flat conical form and a diameter of 10 mm. to 15 mm. The upper smaller half (in the lateral view, fig. 8) is the nectosome, composed of the pneumatophore and the corona of bracts. The lower larger half is the siphosome, with the palpons, siphons, tentacles, and gonostyles.

Nectosome.—The superior half of the flatly conical corm is the nectosome, composed of a large pneumatophore (*p*) and of a corona of numerous bracts. These latter were nearly all detached and lost, except a few (fig. 9, *b*); but the lamellar pedicles of the bracts and the basal ribs of their attachment to the nectosome (*bp*) were well preserved, and exhibited the peculiar arrangement described above (p. 271). The bilateral conical nectosome is bisected by the series of buds in the ventral median line. The uppermost part of the nectostyle is prominent over the ventral side of the pneumatophore and bears a cluster of very young buds (*ib*). From this blastocrene (or the punctum vegetationis of the nectophores) diverge five or six pairs of radial ridges, each of which is composed of four fine parallel ribs, bearing the pedicles of the bracts. The youngest ribs are undulating, and placed on both sides of the ventral median line vertically (fig. 9); the oldest ribs are straight, and run nearly horizontally and perpendicular to the former, embracing the upper half of the pneumatophore like a cowl.

Pneumatophore (figs. 7–9, *p*).—The float is an ovate vesicle, which occupies the upper half of the conical trunk. Its dorsal side (fig. 7, *p*) is free and exhibits above the pigment-star of the apex, below a corona of sixteen radial stripes (probably radial septa between the pouches of the pneumatosac). The ventral side (fig. 9, *p*) and the greater part of the lateral sides (fig. 8) are covered by the embracing cucullate nectostyle and by the corona of bracts attached to it. (Compare above.)

Bracts (fig. 9, *b*).—The bracts of this species are probably very numerous and attached to the trunk of the nectosome in the peculiar order described above (p. 271). But nearly all the bracts were detached and lost in the only observed spirit specimen. A few only were preserved (fig. 9, *b*), and these were oblong or lanceolate leaves, with a basal pair of lateral teeth beyond their lamellar pedicle. The concave inner or axial side of the bract is smooth, the convex outer or abaxial side armed with a number of parallel cnidal ribs (six to eight ?).

Siphosome.—The inferior half of the conical corm is the siphosome, composed of a superior corona of very numerous palpons (*q*) and an inferior corona of cormidia, each of which bears a siphon (*s*), a tentacle (*t*), a male and a female gonodendron (*g*). The peculiar arrangement of these ordinate cormidia and their relation to the quadripartite groups of bracts has been described above (p. 271). The full number of cormidia in the specimen observed was probably ten or twelve, the youngest and smallest placed in the ventral median line, the oldest and largest in the dorsal median line (fig. 8, lateral view, from the left side). The blastocrene of the bilateral siphosome, or the series of buds in

its ventral median line (fig. 9, *is*), bisected it so regularly that the cormidia were ordinate symmetrically right and left.

Siphons (figs. 7–9, *s*).—The size of the polypites, according to the ordinate bilateral arrangement just mentioned, increases from the ventral towards the dorsal side (fig. 8, *s*). They were ovate thick-walled sacs, strongly contracted in the only spirit specimen observed. The structure of the siphons is probably the same as in *Athorybia* (Pl. XII. fig. 10).

Tentacles.—The greatest part of the tentacles were detached and lost in the spirit specimen observed; a few fragments only remained. The tentilla were of two kinds, and apparently both of the same form as described and figured by Fewkes in his *Athorybia formosa* (*loc. cit.*, p. 274, pl. vi. figs. 7–10). The smaller and more frequent form of cnidosacs is similar to that figured in *Athorybia ocellata* (Pl. XII. figs. 11–13). The larger and rarer form exhibits besides two large dorsal dendritic appendages, which were dichotomously branched, of the same shape as in *Anthophysa formosa* (Fewkes, *loc. cit.*, fig. 7, lateral view, from the right side, fig. 8, basal view).

Palpons (figs. 7–9, *g*).—The tasters were very large and numerous in the specimen observed, and composed a multiple corona beyond the corona of bracts. Their form is slender, spindle-shaped, tapering towards the attached basal and the closed distal ends.

Gonophores (*g*).—Close to the base of each siphon are attached to the siphosome two small branched gonodendra, a male and a female. Their structure is similar to that of *Athorybia* (Pl. XII.), the spermaria (fig. 17) as well as the ovaria (fig. 18).

LATER ADDITION TO THE ANTHOPHYSIDÆ.

Plœophysa agassizii, Fewkes.

Plœophysa agassizii, Fewkes, Ann. and Mag. Nat. Hist., ser. 6, vol. i. pp. 317–322, pl. xvii., 1888.

While correcting the proof of this sheet, I have received a paper by Mr. J. Walter Fewkes, published in May 1888 (*loc. cit.*), and entitled: On a New Physophore, *Plœophysa*, and its Relationships to other Siphonophores. A comparison of the two figures representing it (drawn from two small spirit specimens from the Gulf Stream, found in a bottle from the "Albatross" Expedition, 1886), and of my figures of *Anthophysa darwinii* (Pl. XII. figs. 8, 9, printed in 1887), informs us that these two Anthophysidæ are very closely allied, or perhaps identical. *Plœophysa* of Fewkes is an Anthophysid (either *Athorybia* or *Anthophysa*) which has lost its bracts, and the pneumatophore of which, highly retracted, is embraced on the ventral side by the prominent cucullate nectostyle. Fewkes calls this lamellar cowl-shaped nectostyle the hood, "and supposes it to be a new organ, elsewhere unknown among Physophores in this form" (p. 318). He even regards *Plœophysa* as the type of a new family—Plœophysidæ (p. 320).

Order IV. AURONECTÆ, Haeckel, 1888.
(Pls. I.–VII.)

Auronectæ, Hkl., System der Siphonophoren, p. 43.
Aurophoridæ, Hkl., *ibid.*, p. 6.

Definition.—Siphonophoræ with a large pneumatophore, a corona of nectophores, a peculiar aurophore, and a network of canals in the thickened trunk. Nectosome composed of a horizontal corona of nectophores beyond the voluminous spheroidal pneumatophore, and a singular pneumadenia (the large subspherical aurophore), placed in the dorsal median line of the corona. Siphosome spheroidal, ovate or turnip-shaped, with a thick, bulbous, cartilaginous trunk, traversed by a dense network of anastomosing gastro-canals; its surface densely covered by numerous cormidia, each of which bears a single siphon with a tentacle, and one or more gonodendra.

The order Auronectæ is represented by a few Siphonophoræ of the deep sea, which were discovered by the Challenger, and which differ so widely in their entire organisation from all other animals of their class, that it is impossible to place them in any of the four other orders. The large apical pneumatophore, of an enormous size, is similar to that of the Physalidæ among the Cystonectæ; the corona of numerous nectophores (wanting in these latter) resembles that of some Physonectæ (Circalidæ, Forskalidæ); but the remarkable organ of the nectosome which we call aurophore is found in no other group of Siphonophoræ, and is exclusively peculiar to the Auronectæ. The same holds good of the thickened bulbous trunk of the siphosome, which is traversed by a network of anastomosing canals, similar to the fleshy or cartilaginous cœnosome of the Alcyonidæ.

The few species of Auronectæ which I have examined were preserved in spirit in rather good condition, and seem to represent two different families of this order, Stephalidæ and Rhodalidæ. The smaller Stephalidæ (with the genera *Stephalia*, Pl. VII., and *Stephonalia*, Pl. VI.) seem to be allied to the Circalidæ among the Physonectæ (*Circalia*, Pl. XXI. figs. 1–4). Their bulbous trunk exhibits an axial central canal, with a mouth at the distal end (Pl. VII. figs. 40, 48). The tentacles are simple, without tentilla. The second family contains the larger and more highly developed Rhodalidæ (*Rhodalia* and *Auralia*, Pls. I.–V.). The axial central canal of the bulbous trunk has here disappeared, or is replaced by a central cavity; its distal mouth-opening is lost (Pl. IV. fig. 15). The tentacles are compound, with a series of lateral branches or tentilla, similar to those of the Forskalidæ. The young larval forms of the Rhodalidæ seem to be little different from the adult Stephalidæ.

Nectosome and *Siphosome.*—The two main portions of the corm, swimming and feeding body, are both distinguished in the Auronectæ by a peculiar development. The

nectosome, in the superior or apical half of the corm, is composed of three different portions: (1) a gigantic spheroidal or lenticular pneumatophore; (2) a horizontal corona of numerous radially arranged nectophores beyond the float; and (3) a pyriform or subspherical aurophore placed in the dorsal median line of the corona, probably an enlarged pneumadenia. The siphosome, which occupies the inferior or basal half of the corm, is composed of a large bulbous axial trunk and of numerous peripheral cormidia, which cover its whole surface. Each cormidium bears upon a short common pedicle a single siphon with a tentacle and one or two monoclinic gonodendra, provided with one or more sexual palpons.

Pneumatophore (*p*, Pl. I. fig. 1; Pl. III. figs. 13, 14; Pl. IV. fig. 15; Pl. VI. figs. 32, 33; Pl. VII. figs. 39, 40, 48, 50).—The apical float filled with air is very voluminous, comparatively larger than in any other known Siphonophoræ, with the sole exception of the Physalidæ. It is about half as large as the bulbous siphosome and has the form of an inflated lens or a flattened spheroid, its vertical diameter (or central axis) being usually only half as long as the horizontal diameter (or the transverse axis); the former in the largest specimens of *Rhodalia* measures 10 to 11 mm., the latter 20 to 22 mm. The horizontal section of the pneumatophore (figs. 1, 16, *p*) is circular, the vertical section (figs. 15, 40, 50, *p*) elliptical. The greatest part of its surface is free and smooth. Only the lower surface is attached to the truncated proximal face of the stem and separated from it by the flat horizontal hypocystic cavity (figs. 15, *aa*, 40, *ah*). The dorsal side of the pneumatophore bears at its base the large aurophore (*l*), whilst on the opposed ventral side the set of buds is placed (Pl. IV. fig. 15, *i*).

Although the development of the pneumatophore in the Auronectæ is unknown, there can be no doubt that it originates in the same way as in the Physonectæ and Cystonectæ; it represents, as in these latter, the modified umbrella of a Medusa, the manubrium of which is the trunk of the siphosome (Pl. VII. figs. 40, 50). Since the large air-sac is produced by an invagination of the apical part of the tubular trunk or cœnosome, its wall is hollow, and the cavity of the wall filled by nutritive fluid; the pericystic cavity (Pl. V. fig. 24, *ps*) communicates below with the flat hypocystic cavity (Pl. IV. fig. 15, *aa*). This latter is a simple circular or lenticular cavity without septa. But the pericystic cavity is traversed by a variable number of irregular trabeculæ or radial septa, which connect the thicker outer wall (pneumatocodon) with the thinner inner wall (pneumatosaccus).

Pneumatocodon.—The outer wall of the float (Pl. V. figs. 24, 30, *z*) is rather thick, very firm and elastic, and is composed of five strata, viz.—(1) the outer exodermal epithelium (*e*); (2) a subjacent layer of longitudinal or radial muscles; (3) a thick fulcral plate (*z*); (4) a thin stratum of circular muscles; and (5) an inner exodermal epithelium (*d*). The exodermal cell-layer, or the epidermis, is a thin and flat pavement epithelium. The strong subjacent muscle-plate is composed of longitudinal fibres which diverge

radially from the apical centre of the float and surround it like meridional arches (fig. 40). Sometimes eight stronger equidistant radial muscles are developed (fig. 33). The fulcrum, or the supporting gelatinous plate, is a hyaline and structureless cartilaginous lamella 0·2 to 0·5 mm. thick; it is twice as thick in the peripheral as in the apical part of the float. The fulcrum is pierced (mainly in the basal periphery) by a variable number of simple or branched radial cords, which connect its inner and outer epithelium. They are partly solid apophyses of the entoderm (fig. 30, d_1), partly nutritive canals; sometimes these canals seem to open on the outer surface of the pneumatocodon. The stratum of ring-muscles which lies inside the fulcrum is thinner than the outer layer of radial or longitudinal muscles; but sometimes the circular muscles are also well developed, and effect a horizontal annulation of the float. *Stephonalia* (Pl. VI. figs. 32, 33), which exhibits outside eight strong radial muscle-bands, is distinguished also by a peculiar development of parallel muscle-rings on the inside of the pneumatocodon. The entodermal epithelium which lines the inside is always composed of large cylinder-cells (fig. 30, *d*).

Pneumatosaccus.—The air-sac, or the inner (originally invaginated) wall of the pneumatophore, is of the same form as the somewhat larger surrounding pneumatocodon (or the outer wall), separated from it by the pericystic cavity (fig. 24, *ps*), and connected with it by the above-mentioned numerous trabeculæ. The inner wall is much thinner than the outer, and composed of three plates only, viz.—(1) the entodermal epithelium composed of high cylinder-cells (Pl. V. fig. 24, d_1); (2) a rather thin, but firm and elastic fulcrum (the structureless supporting plate, fig. 24, z_1); and (3) the exodermal epithelium composed of much smaller cells (fig. 24, e_1); this inner surrounds and produces the pneumatocyst.

Pneumatocyst.—The air-flask of the Auronectæ is a thin but firm and elastic cuticle, secreted and surrounded by the pneumatosac, therefore of the same form and size. It has no apical stigma, as in the Cystonectæ, but is everywhere closed, except at the single basal opening, which we call auropyle (Pl. IV. fig. 16, *li*, seen from above; Pl. V. fig. 24, *li*, seen in the sagittal section). This auropyle lies excentrically in a small circular dimple on the dorsal base of the pneumatocyst, in its sagittal axis. The periphery of this dimple (foveola auropylæ) marks the internal boundary between the pneumatophore and the attached aurophore. The chitinous plate of the pneumatocyst seems to be continued directly into the vagina pistilli (*lf*). Compare below.

Aurophore (Pl. IV. figs. 15, 16, *l*; Pl. V. figs. 24–28; Pl. VII. figs. 39, 40, 43, *l*).—The aurophore or air-bell of the Auronectæ is a peculiar and most remarkable organ, wanting in all other known Siphonophoræ; it seems to be the modified umbrella of a medusome, or a peculiar medusoid person, which was originally a modified nectophore, and adapted to the production and emission of the gas contained in the large pneumatophore. The form of the aurophore (*l*, Pl. I. fig. 1; Pl. III. figs. 13, 14; Pl. IV. figs. 15, 16) is roundish, nearly globular or somewhat pear-shaped; it is attached by a broad

base to the inferior part of the dorsal side of the pneumatophore and placed in the sagittal plane. In *Stephalia* (Pl. VII.) it is of the same size as a nectophore; in *Rhodalia* (Pl. III.) much smaller. The comparison of the vertical sagittal section (Pl. V. fig. 24; Pl. VII. fig. 40) and of the vertical frontal section (Pl. V. figs. 25, 26) proves that the aurophore possesses a singular medusoid structure; it is pierced by a cylindrical central canal, the auroductus (*la*) running in a nearly horizontal direction and opening inside into the cavity of the pneumatophore by the auropyle (figs. 16, 24, *li*), outside by an external mouth, the aurostigma (figs. 15, 24, 40, *lo*). The auroduct or central canal is lined inside by a thick-walled peculiar tube, the pistillum; while it is surrounded outside by a number of radial chambers, which are separated by septa and communicate with the pericystic cavity of the pneumatosaccus.

The remarkable structure of the single parts of the aurophore, compared with the corresponding parts of the nectophores and the pneumatophore, makes it probable that the aurophore is a modified nectophore, transformed into a pneumadenia; in this case it has the morphological value of a medusoid person. On the other hand, it is possible that it was originally only a secondary organ of the pneumatophore, a basal apophysis of the air-funnel (Pl. VII. fig. 50). Perhaps its outer opening corresponds to that which the Discolabidæ exhibit at the base of the pneumatophore.

The transverse section of the aurophore (Pl. V. fig. 25, in the proximal part; fig. 26, in the middle part) exhibits in its outer wall from outside to inside the following five strata:—(1) A simple exodermal epithelium (*e*) composed of rather flat small cells; (2) a muscular plate composed of longitudinal muscle-fibrillæ, which are probably direct prolongations of the epithelial cells; (3) a thin cartilaginous fulcral plate (*z*), much thinner than the same fulcrum of the pneumatophore, but very firm and elastic, consisting of structureless jelly, strongly stained by carmine; (4) a thin layer of ring-muscles; (5) a thick entodermal epithelium, composed of very large cylindrical cells.

The same five strata recur also in the inner wall of the aurophore, following, however, in the inverse order; the entoderm lying outside, the exoderm inside. The latter surrounds the central cavity of the aurophore, which is filled by the pistillum; between them is visible the vagina pistilli, a structureless tube (*lf*) intensely stained by carmine; it seems to be a chitinous cuticular membrane, formed by a direct prolongation of the pneumatocyst (*pf*).

The outer wall of the aurophore (exumbrella) and the inner wall (subumbrella) are connected by a variable number of radial septa; and by these are separated wide radial chambers (figs. 24–26, *lr*). These correspond probably to the radial pouches of the pneumatophore in the Physonectæ, and to the radial canals of the medusoid nectophores; they are, however, much wider than the latter. Their number is variable; usually between eight and twelve. In the middle part of the aurophore (in transverse sections which cut the pistillum at right angles in its middle part) eight to twelve radial

chambers appear sometimes rather regular (fig. 26, *lr*); but in other transverse sections (more proximal and oblique, placed nearer to the auropyle, fig. 25) the number, size, and form of the radial chambers is rather different, owing to the ramification and arrangement of the separating radial septa. Near the auropyle this arrangement is so symmetrical that the form of the transverse section is quite bilateral (fig. 25).

The fulcrum of the outer as well as of the inner wall of the aurophore arises between the radial septa in the form of numerous smaller and larger crests which project into the cavities of the radial chambers, and these crests are covered by high folds of the entoderm. The form of the canal-system of the aurophore becomes very complicated by further development of these entodermal folds, and in the largest specimens examined assumes the shape of a spongy system of irregular lacunæ. The great internal surface of the entodermal epithelium, thus produced, together with the extraordinary size and glandular appearance of its high cylindrical cells (fig. 27, *d*), make it probable that the great mass of air contained in the pneumatophore is secreted by the lacunar system of the aurophore and conducted into the cavity of the pneumatocyst by pores, which pierce the inner wall of the aurophore.

Pistillum (Pl. V. figs. 24–26, *lp*).—The peculiar body, which fills up the cylindrical central cavity of the aurophore, and which we call provisionally pistillum, is a very remarkable organ, the true morphological signification of which cannot be fully recognised without knowledge of its development. It seems not to be comparable with any structure known hitherto in other Siphonophoræ (except perhaps the tapetum endocystale of the Physonectæ?), and is a singular production of the Auronectæ. The comparison of the sagittal section of the aurophore (Pl. V. fig. 24) with the transverse sections (figs. 25, 26) informs us that the pistillum is a cylindrical tube, with a very thick wall and a narrow axial canal (*la*). Its wall is composed of three different strata, the inner of which is epithelial (*le*), the middle muscular (*lp*), and the outer cuticular (vagina pistilli, *lf*). The narrow axial canal of the aurophore (figs. 24–26, *la*) runs in its middle part nearly horizontally; its proximal or inner part is turned obliquely upwards and opens into the cavity of the pneumatophore by the auropyle (*li*); its distal or outer part is turned obliquely downwards and opens externally by the aurostigma (*lo*). The simple epithelium (fig. 28, *le*) which lines the axial canal (*la*) is composed of small cubical cells, and seems to be a direct continuation of the exodermal epithelium; both are in continuity at the thickened lips of the aurostigma (fig. 24, *lo*). The main mass of the pistillum is composed of prolonged fusiform cells which have the greatest resemblance to spindle-shaped muscle-cells (fig. 28, *lm*). All these spindle-cells run parallel one to another and to the axis of the auroduct, and their oblong nuclei (fig. 28, *ln*) have also the same direction. The protoplasm of the spindle-cells is finely granulated, opaque, yellowish, and sometimes it seems to be transversely striated. Therefore the entire mass of the pistillum (besides the axial epithelium) seems to

be a bundle of parallel spindle-shaped muscle-cells, and is probably an inner prolongation of the exodermal muscle-stratum of the outer wall. The inner insertion of the pistillum forms a broad circular ring in the "foveola auropylæ" of the pneumatophore. This foveola (fig. 16, *pl*) contains the auropyle or the inner opening which leads from the axial canal of the aurophore into the large cavity of the pneumatophore. The longitudinal muscle-fibres of the pistillum diverge here in a radial direction horizontally, and are inserted at the circular margin of the foveola, ending abruptly with a sharp boundary line on the pneumatocyst (fig. 24, lp^1).

Judging from these peculiar structures of the pistillum, we suppose that it acts as a strong muscle, by the contraction of which the aurophore is opened and the air contained in the pneumatophore expelled. Its morphological explanation is very difficult; one might suppose it to be a part of a modified stomach (manubrium) of the medusoid person; more probably, however, it is a secondary apophysis of the exoderm only (similar to the endocystic tapetum of the Physonectæ), grown inside from the spiraculum into the central cavity of the aurophore, which corresponds to the umbrella-cavity of the Medusa. In this case the margin of the aurostigma (*lo*) may be compared perhaps with the umbrella margin of the Medusa, and the pistillum with its velum turned inside into the umbrella cavity (?).

Nectophores (*n*).—The nectocalyces or swimming-bells form an elegant corona round the base of the pneumatophore. This corona is simple in *Stephalia* (Pl. VII. figs. 39, 40, 48) and in *Auralia;* it is multiple in *Stephonalia* and *Rhodalia* (Pl. I. fig. 1; Pl. II. fig. 6; Pl. III. figs. 13, 14). The circular corona is bisected in the sagittal plane of the body, on the dorsal side by the aurophore (*l*), on the ventral side by the set of buds (*i*). The nectophores are pyriform medusoid persons of equal size; their number is eight to sixteen in *Stephalia*, twenty to thirty in *Stephonalia*, fifty to eighty or more in *Rhodalia*.

Pedicles of the Nectophores.—The swimming-bells are attached on the periphery of the cylindrical nectosome (or the upper half of the bulbous trunk) by means of large lamellar pedicles, similar to mesenterial plates (Pl. III. figs. 13, 14). Each pedicle is a thin transparent lamella of quadrangular or nearly square form, and consists of a cartilaginous vertical jelly-plate placed in a meridional plane of the trunk. The thinner upper and the thicker lower margins of the pedicle are free; the inner or axial margin is thickened and arises by a broad base from the cœnosome; the outer or abaxial margin passes over into the conical apical part of the nectophore (Pl. IV. fig. 16, *np*). A wide canal, the peduncular canal of the nectophore (Pl. V. fig. 31, *ns*), arising from the network of canals in the cœnosome, and placed radially to its vertical main axis, runs horizontally along the thickened lower margin of each pedicle, and gives off at right angles a series of twenty to thirty small, lateral, vertically ascending branches. These branches, or the "secondary peduncular canals" (*nl*), are therefore directed parallel to one another and to the vertical main axis of the trunk; they are single, blind, slightly curved or undulating,

and decrease gradually in size from the axial to the abaxial margin of the pedicle. The distal or abaxial end of the horizontal main canal (*ns*) of the pedicle passes over into the canal-cross which is formed by the four radial canals of each nectophore. The jelly-lamella of the pedicle is covered on both sides by a strong muscular plate composed of horizontal parallel bundles of radial muscle-fibres, which run parallel to the upper and lower margins of the pedicle (fig. 31, *nm*). The surface of the muscular plate is covered by a flat pavement epithelium of the exoderm.

The arrangement of the nectophores around the trunk is different in the various genera of Auronectæ. All the swimming-bells lie in a single horizontal plane, radially arranged, in *Stephalia* and *Auralia* (Pl. VII. figs. 39, 40, 48). But in *Stephonalia* and in the larger *Rhodalia*, where they are much more numerous, they compose probably three alternating horizontal rings, as is supposed in the semi-diagrammatic figures (Pl. III. figs. 13, 14). In the specimens preserved in spirit examined, the majority of the nectophores were detached from the cœnosome and their form much altered by contraction. The remaining axial parts of their pedicles, however, densely placed parallel in regular narrow intervals, allowed their arrangement around the trunk to be recognised with great probability (Pl. I. fig. 1; Pl. III. figs. 13, 14). Therefore, this may be very similar to that of *Forskalia* among the Physonectæ (Pl. VIII.), with this difference, however, that in *Forskalia* the common stem is much longer and more slender than in *Rhodalia*. Therefore, the spiral column of the nectophores in the nectosome is here much broader and not so high as in the former. The nectophores of the living adult *Rhodalia* compose probably three transverse series, disposed quincuncially, and so alternating, that those of the first and third transverse series are placed in the same meridional plane of the stem, whilst those of the second transverse series are interpolated between the first and third. But this quincuncial arrangement is only produced by mutual pressure and dislocation of the nectophores, the basal pedicles of which form a single corona (fig. 14). Probably the form of the pear-shaped nectophores is polyhedral by mutual compression in the living animal, whilst it is more roundish in the contracted spirit specimens.

Each nectophore is a medusiform bell, the pear-shaped umbrella of which is composed of a rather thick and firm jelly-plate. Its inside is covered by a strong muscular subumbrella, composed of circular fibres. The entrance (figs. 6, 16, *w*) into the wide cavity of the nectosac is closed in the periphery by a broad circular velum, which projects from the margin of the umbrella (figs. 13, 16, *v*). The entire surface of the nectophores, as well the outside (exumbrella) as the inside (subumbrella), is covered by a flat pavement epithelium. The main axis of the nectophores is radial to the vertical main axis of the trunk, and therefore horizontal in the middle transverse row of nectophores; it is somewhat ascending in a centrifugal direction in the upper row, and somewhat descending in the lower row (figs. 13, 14).

The nutritive canal-system of each nectophore (Pl. IV. fig. 17, *n*) is, as usual,

composed of four equidistant simple radial canals (*nr*), which arise from the distal or abaxial end of the primary peduncular canal, run in the subumbrella to the margin of the jelly-bell, and are there united by a circular canal (*nc*), placed above the insertion of the velum (*v*). Compare Pl. VII. figs. 39, 48.

Truncus.—The common stem of the corm, or the cœnosarc, exhibits in the Auronectæ a most remarkable form and structure, very different from that of all other Siphonophoræ. It is a large solid bulb of a cartilaginous consistence, sometimes subspherical (Pl. IV. fig. 15, *a*), at other times more spindle-shaped or truncately conical (Pl. VII. fig. 40, *a*). Its size is usually about equal to or double that of the pneumatophore. The solid mass of the cartilaginous trunk is structureless and colourless, hyaline, very similar to the hyaline fundamental substance of common cartilage. It is traversed everywhere by a dense network of innumerable small canals, anastomosing one with another, and with the large hypocystic cavity (Pl. V. fig. 24, *ac*). The network is very similar to that in the fleshy cœnosarc of the common *Alcyonium*; but the numerous asteroidal connective cells, which are scattered in the fundamental substance of this latter between the vessels, are wanting in the Auronectæ; exceptionally here a few mesenchymatous entoderm-cells step out from the vessels and remain isolated in the fundamental substance. The network of these nutritive vessels or gastro-canals forms on the surface of the trunk a superficial net, from which the canals of the cormidia arise. The entodermal epithelium which lines the canals is composed of high cylindrical cells, forming a single layer (Pl. V. fig. 29).

The Stephalidæ (*Stephalia*, Pl. VII. fig. 40) differ from the larger Rhodalidæ (*Rhodalia*, Pl. IV. fig. 15) in the possession of a wide, cylindrical, central canal (*ca*), which descends vertically in the main axis of the turnip-shaped trunk and opens at its distal pole by a mouth. This terminal mouth is sometimes much larger than the mouth-openings of all the other siphons (Pl. VI. figs. 32, 33, *ap*). There can be no doubt in my opinion that this important axial canal is the gastral cavity of the protosiphon, or the primary siphon of the larva, which is the manubrium of the original medusome. Its distal opening is the original Medusa-mouth. This explanation becomes evident by the comparison with the youngest larva observed (*Auronula*, Pl. VII. fig. 50). The entire siphosome is here represented by the single primary siphon. By thickening of its wall and development of nutritive canals in it arises the vascular bulbous trunk of the Auronectæ. It corresponds to the basal protosiphon at the distal end of the Physalidæ, and to the sterile central siphon of the Disconectæ.

Cormidia.—The entire surface of the bulbous trunk beyond the corona of nectophores is in all Auronectæ densely covered with numerous cormidia. Their number is in the smaller Stephalidæ twenty to fifty or more, in the larger Rhodalidæ sixty to eighty, often more than one hundred, or even several hundreds. The cormidia are always monogastric and originally ordinate, arranged in regular circles or spiral coils

(Pl. IV. figs. 16, 17); but the intervals between the neighbouring cormidia, or the internodes of the stem, are so small, that the arrangement often appears to be more irregular, and the whole surface of the siphosome is like a bunch of cauliflower (Pl. II. fig. 6; Pl. III. figs. 13, 14). Each cormidium arises from the surface of the common trunk by a thickened base, which is sometimes a short conical protuberance, at other times a longer cylindrical pedicle, or a lateral branch of the trunk (Pl. IV. figs. 15, 16). Sometimes the cormidia seem to arise united in small groups from a common pedicle, and if we regard one of these groups as a single cormidium of higher order (or a main-branch of the trunk), we may say that the cormidia are polygastric (Pl. VI. figs. 34, 35). In some specimens (or perhaps in certain species?) the arrangement seems to be more irregular, and the cormidia more or less loose. The common pedicle of each cormidium is traversed by a network of anastomosing canals, often with a wider axial main canal.

Each cormidium is originally composed of the following four organs (Pl. VI. fig. 37): (1) a single siphon (*s*); (2) a long tentacle arising from its base (*t*); (3) a clustered monostylic gonodendron (*g*); and (4) a slender palpon arising from its distal portion (*q*). This regular composition of the monogastric and ordinate cormidia is obvious in the majority of the specimens examined. But in some specimens of larger size the two main branches of the very large gonodendron are so deeply divided, that two gonodendra arise separately from the common base of the cormidium (Pl. I. fig. 2). More rarely there are single cormidia, in which the two gonodendra (or only one of them) are again forked, so that three or even four gonodendra arise from separate pedicles.

Siphons (Pl. IV. figs. 19, 20, *s*; Pl. VI. figs. 32–38, *s*; Pl. VII. figs. 39–42, *s*).—The feeding polypites of the Auronectæ exhibit in general the same form and structure as in the Physonectæ. They are in the spirit specimens observed all more or less contracted, thick-walled, spindle-shaped or cylindrical tubes, tapering towards the basal as well as the distal end. Their length in the small Stephalidæ is 2 to 4 mm., in the large Rhodalidæ 8 to 10 mm.; their breadth in the former 0·6 to 0·8, in the latter 2 to 3 mm. In the expanded state they may reach double the size or more. The four usual segments of the siphons are often very distinct. The cylindrical pedicle (*sp*) which arises from the cormidium is a thick-walled cylindrical tube of variable length, opening inside in the main canal of the cormidium, outside in the basigaster. The transverse section of the pedicle is very similar to that of a gonostyle (Pl. I. figs. 4, 5); it exhibits a thick, structureless, cartilaginous fulcrum, from the convex outside of which arise numerous branched radial folds (z^1). These bear the parallel fibres of the longitudinal muscles (*ml*), while the concave inside of the fulcrum is lined by a thin muscle-plate composed of circular fibres (*mc*). The entodermal epithelium, inside the latter, forms a single layer of high cylindrical cells (*d*), whereas the exodermal epithelium covering the outside is stratified, composed of three to six or more layers of polyhedral cells (*e*).

The second segment of the siphons is the basigaster (figs. 37, 38, *sb*), usually a hemi-

spherical or pyriform portion, the thickened exoderm of which is full of cnidocysts. From its base arises the single tentacle (figs. 35, 37, 42, *t*). The basigaster is separated from the pedicle as well as from the stomach by an annular constriction (sphincter). The basal sphincter is a very strong ring-muscle, and it is very probable that by its sudden contraction the three distal segments are frequently detached from the proximal pedicle. In my preliminary examinations of the large and well-preserved specimens of *Rhodalia miranda* collected by the Challenger, I could find in them neither siphons nor tentacles. I saw only the pedicles of the siphons attached to the cormidia, and judged them to be the highly contracted siphons, and their opening (the pylorus basalis) to be the true mouth. I was thus led into the same error as Gegenbaur thirty years before in *Stephanospira*. Some time afterwards I examined accurately the masses of horse-hair covering the bottom of the vessel in which the *Rhodalia* had been packed by the naturalists of the Challenger. There were entangled between the horse-hairs some irregular whitish lumps composed of interwoven long filaments and nodes. Further careful examination convinced me that the long coiled up filaments were the tentacles of *Rhodalia*, and the nodes were the detached siphons connected with the former (Pl. IV. fig. 20). A long time afterwards I received from Dr. John Murray the complete specimens of *Stephalia corona* taken in the "Triton" Expedition (1882), and in these the majority of the siphons and tentacles were still connected with the cormidia (Pl. VII.). Supported by this confirmation of my suggestions, I was able to restore the anatomy of *Rhodalia*, and to draw the entire corm with that completeness which is figured in Pl. III. At the same time this experience teaches afresh the lesson that much care and critical judgment must be employed in the anatomical examination of preserved specimens of Siphonophoræ, and of such specimens as come up in the tow-net or trawl from the deep-sea. Many parts of the corms, especially the nectophores and tentacles, but also often the siphons and palpons, are so easily detached, that they seem to be entirely wanting. I have no doubt that the "deep-sea Siphonophoræ, without tentacles," which have been described by Studer (**40**), Fewkes (**45**), and by former authors, are corms which have lost the tentacles during capture.

The stomach (*sm*), as the third and largest portion of the siphons, is a long cylindrical or spindle-shaped tube, often ovate in the inflated state, and separated by an annular constriction from the two neighbouring segments, the proximal basigaster (*sb*) and the distal proboscis (*sr*). It is easily distinguished from both by the dark longitudinal liver-stripes, which extend parallel and equidistant in its whole length (Pl. IV. fig. 20, *sh* ; Pl. VI. figs. 35, 38, *sh* ; Pl. VII. fig. 42, *sh*). The number of these hepatic ridges seems to be variable, sometimes eight, at other times twelve or sixteen. After removal of the glandular entoderm, the remaining exoderm of the stomach exhibits a large number of longitudinal parallel muscle-bands (Pl. IV. fig. 19, *ml*). No doubt the siphons are very expansible and contractile, as usual.

The proboscis, the fourth and last segment of the siphon, is in the spirit specimens examined usually short, highly contracted, and conical (Pl. IV. figs. 19, 20, *sr*; Pl. VII. fig. 42, *sr*). Often its proximal part is invaginated and turned over by the reflexed distal part (Pl. VI. figs. 35, 37, 38, *sr*). Sometimes four or eight strong longitudinal muscle-bands may be distinguished in the outer wall of the proboscis. The inner wall seems to be beset with peculiar glandular cells. The distal mouth is usually highly contracted, circular, with a thickened labial margin; often it shows a circle of radial folds or lobes, the number of which is sometimes four or eight, at other times twelve or sixteen (Pl. VI. figs. 35, 37, sr^1).

Tentacles.—Each siphon bears in the Auronectæ, as in all other Siphonanthæ, a single long tentacle, and this arises from the basigaster, near its basal part. As mentioned above (p. 290) the tentacle remains attached to the basigaster, when the siphon becomes separated from the cormidium by self-amputation (sudden contraction of the basal sphincter), whereas the pedicle of the siphon remains attached to the corm.

The tentacles of the Auronectæ appear in two different forms, characteristic of the two families of this order. The small Stephalidæ (*Stephalia*, Pl. VII., and *Stephonalia*, Pl. VI.) have simple, not branched tentacles, similar to those of the Apolemidæ and *Linophysa*. The large Rhodalidæ, however (*Rhodalia*, Pl. III.; Pl. IV. figs. 20–23), possess branched tentacles, like the majority of Physonectæ; each tentacle bears a series of very numerous tentilla or lateral branches; in form and structure (fig. 23) they are very similar to those of the Forskalidæ.

The simple tentacles of the Stephalidæ are long and thin cylindrical tubules, and arise from the dorsal side of the basigaster near its pedicle (Pl. VII. figs. 39, 40). They are usually very much contracted in the spirit specimens examined, and not much longer than the siphons; but in the expanded state and in the living animal they are probably very long, several times longer than the whole corm. The tentacles of *Stephalia* (Pl. VII. figs. 39, 40) are all of the same size and similar form, not annulated, with equally disposed cnidocysts. But *Stephonalia* (Pl. VI.) possesses two different kinds of tentacles, larger superior and smaller inferior. The thinner tentacles, much more numerous, agree with those of *Stephalia*. The thicker tentacles, only developed in the proximal part of the trunk, are far larger cylindrical tubules, and appear elegantly annulated when examined by a weak lens; each prominent annulus is composed of densely crowded cnidocysts, wanting in the small constricted interval between each two rings (Pl. VI. figs. 35, 37, 38, *t*). The distal part of these thicker tentacles has a peculiar structure; it represents a cylindrical, articulated terminal filament, composed of about a dozen segments, and bearing no annuli of cnidocysts (figs. 35, 37, *tf*).

The branched tentacles of the Rhodalidæ have a similar but more complicated structure, and each bears a series of very numerous tentilla or lateral branches. The cylindrical tube, which is 1 to 1·5 mm. in diameter, may reach in the fully expanded state

a length of 1 metre or more. It is annulated in the same manner as the simple tentacle of the Stephalidæ; but from the interval between each two annuli arises a tentillum or accessory filament (Pl. IV. figs. 20–22). The line in which these numerous tentilla are inserted is the dorsal median line of the cylindrical tentacle. From the opposite ventral median line arises a very thin and broad ligament, the suspensorium tentaculi (Pl. VII. fig. 42, *tg*); it is similar to the well-known suspensorium or tentacle-band of the Physalidæ; and as in these latter, the tentacle when contracted is coiled up spirally around this axial ligament. The transverse section of the tentacle, when magnified, shows us that the elastic ligament is composed of a solid lamellar apophysis of the cartilaginous fulcrum (Pl. IV. fig. 21, *tl*), and is covered by a single layer of exoderm-cells (*e*).

The structure of the tentacle visible in the transverse section (Pl. IV. fig. 21) is similar to that of other Siphonanthæ. The cylindrical central canal (*c*) is lined by a simple layer of large entoderm-cells (*d*), and this is surrounded by a thin muscular tube composed of circular fibres (*mc*). This entodermal plate is separated from the thicker exodermal wall by a strong gelatinous fulcrum of nearly cartilaginous consistence (*z*). The structureless fulcrum or supporting plate is surrounded in the transverse section by a corona of numerous (seventy to ninety) radii; they are the transverse sections of large longitudinal radial jelly-lamellæ which support the strong longitudinal muscle-fibres (*ml*). The latter appear in the transverse section regularly arranged on both sides of the lamellæ, like a pinnate leaf. The outer envelope of the exoderm (*e*) is very thick and composed of a stratified epithelium including may thread-cells. The circular annuli of the exoderm, composed of the radial supporting lamellæ and the parallel bundles of longitudinal muscles, are not quite complete, but interrupted on the ventral side by the broad elastic ligament of the tentacle or the suspensorium (*tl*).

Tentilla (Pl. IV. fig. 23).—The accessory filaments or tentilla of the Rhodalidæ are simple lateral branches of the main tentacle, arranged in a single series in its dorsal median line. This series is opposed to the large, mesentery-like elastic ligament. The length of the lateral branches, which commence as very small bud-like elevations in the proximal part of the tentacle, increases gradually towards its distal end; the longest tentilla have a length of 5 to 10 mm. or more. The fully developed tentillum (Pl. IV. fig. 23) is very similar to that of *Forskalia* (Pl. X. fig. 23). It consists of three cylindrical parts, viz., a short pedicle (*tb*), a spiral cnidoband (*tk*), and a slender terminal filament (*tf*). The short pedicle (*tb*) is inserted with narrow base in the interval between two thickened annuli of the main tentacle (fig. 22); its epithelium bears only very small cnidocysts. The cnidoband (*tk*) is armed with a strong cnidobattery, and is a thick-walled cylindrical tube coiled up in several læotropic spirals. On its ventral or axial side are attached two strong parallel elastic ligaments (the so-called "angle-bands," fig. 23, *tl*), and on both edges of these a series of very large bean-shaped or ensiform lateral cnidocysts (tk_1), whilst the convex dorsal side of the cnidobattery bears

a regular pavement composed of innumerable small paliform cnidocysts (tk_{II}). The strong cnidofilament protruded from the large bean-shaped cnidocysts is a rather thick and spirally convoluted thread (Pl. VII. fig. 43, A, B). The slender terminal filament of the tentilla (fig. 23, *tf*) is a simple cylindrical blind tube, scarcely half as broad as the battery, and armed with roundish cnidocysts of medium size.

Gastro-canal System.—The system of nutritive vessels of the Auronectæ is more complicated than that of the other Siphonophoræ (with the exception of the Disconectæ). It is composed of the following parts:—(1) *The central hypocystic cavity of the trunk* (Pl. IV. fig. 15, *aa*; Pl. VII. fig. 40, *ah*); a large circular horizontal cavity of discoidal form, the apical wall of which is formed by the lower part of the pneumatophore, the basal wall by the uppermost part of the siphosome. (2) *The pericystic cavity of the pneumatosaccus* (Pl. V. fig. 24, *ps*), enclosed between the thicker outer and the thinner inner wall of the pneumatophore; it gives off small irregular lateral branches which pierce the thick wall of the pneumatocodon (fig. 30). (3) *The cavity of the aurophore* (Pl. V. figs. 24–26, *lr*), divided by numerous irregular, partly radial, partly branched septa into a spongy system of lacunar vessels and radial chambers; the basal part of the aurophore-cavity communicates on its upper side with the cavity of the pneumatophore (fig. 24, *ps*), on its lower side with the central main cavity. (4) *The reticulum of truncal canals* (Pl. IV. fig. 15, *ac*; Pl. VII. fig. 40, *ac*), composed of a dense network of numerous irregularly branched and anastomosing vessels, which pierce the thick cartilaginous bulbs of the trunk in every direction; the centre of this truncal reticulum is in *Stephalia* the axial central canal (fig. 40, *ca*) descending vertically from the centre of the main cavity towards the basal central siphon and opening through its mouth. (5) *The ventral budding canal* (Pl. IV. fig. 16, *ic*), running from the ventral median line of the central hypocystic cavity to the ventral series of buds (*i*), and giving off a lateral branch to each bud. (6) *The nectocalycine ducts*, or the peduncular canals of the nectophores (Pl. V. fig. 31, *ns*), arising from the stem-cavity, running horizontally along the basal edge of the peduncle, and giving off a unilateral series of lateral branches which ascend vertically (fig. 31, *nl*). (7) *The four radial canals of each nectophore* (Pl. IV. fig. 17, *nr*; Pl. VII. fig. 39); they arise crossed from the distal end of the peduncular canal, run along the subumbrella towards the margin of the nectophore, and are there united by a circular canal (fig. 39, *cc*). (8) *The central canal of each cormidium*, and the network composed of its anastomosing branches, often united by subregular elegant arches with the network of the neighbouring cormidia. (9) *The simple siphon cavity* (Pl. I. fig. 4, *c*) composed of four segments (pedicle, basigaster, stomach, and proboscis); it arises from the superficial canal-network of the cormidium and gives off from the basigaster a lateral branch for the tentacle (tentacular canal, Pl. IV. fig. 21, *c*). (10) *The simple gonostyle canal* (Pl. I. figs. 2, 3, *c*; Pl. II. figs. 7, 8; Pl. VII. fig. 49), arising from the superficial canal network of the

cormidia, and branching irregularly, giving off a special canal to each branch of the gonodendron and to each gonophore budding from it. (11) *The palpon canal* (Pl. IV. fig. 18, *q*), the simple blind cylindrical cavity of the gonopalpon, which arises from the distal end of each gonodendron. (12) *The gonophore canal*, running through the pedicle of each gonophore to the centre of its subumbrella, and dividing there into four radial canals which are united at the margin by a ring-canal. (13) *The spermarial canal* (Pl. VII. fig. 46), or the simple central cavity in the axis of each androphore (spadix), arising from the centre of its subumbrella and being the direct prolongation of the gonophore-canal. (14) *The ovarial canal*, arising from the centre of the subumbrella of each gynophore (as the prolongation of its pedicular canal), and running either in the axis of the ovarium as a simple spadix (Pl. II. figs. 9, 10, *c*), or forming an irregular network of spadicine canals around the egg.

Gonodendra.—The corms of the Auronectæ are monœcious, the cormidia monoclinic, and the gonodendra monostylic. Each cormidium bears in the small Stephalidæ a simple gonostyle with a single gonopalpon (*g*), a single androphore (*h*), and several gynophores (*f*), usually between ten and twenty (Pl. VI. figs. 32–38; Pl. VII. figs. 48, 49). The large Rhodalidæ, however, bear on each cormidium one or two clustered gonodendra, each branch of which corresponds to the small monostylic gonodendra of the Stephalidæ, and is composed of a few androphores and a greater number of gynophores; usually a single large gonopalpon is attached to each gonodendron (Pl. I. figs. 2, 3; Pl. II. figs. 6–12; Pl. IV. figs. 15, 18).

Gonostyles (Pl. I. figs. 2–5; Pl. II. figs. 7, 8; Pl. VII. fig. 49, *ab*).—The stems of the gonodendra, or the branched gonostyles, are in the Auronectæ very thick-walled cylindrical tubes, which arise from each cormidium near to the base of the siphon, on its axial side (fig. 48). The wide axial canal of the gonostyle (figs. 2–4, *c*) is convoluted spirally in the highly contracted spirit specimens examined, and surrounded by a strong muscular wall of remarkable thickness. The transverse section of this wall (Pl. I. figs. 4, 5) exhibits the same structure as the pedicle of the siphons. An inner thin layer of ring-muscles (*mc*) and an outer thick layer of longitudinal muscles (*ml*) are separated by a thick elastic fulcrum (*z*). This fulcral plate arises outside in the form of numerous branched radial lamellæ. The stem must be very expansible and contractile in the living animal. The branching of the gonostyles is unilateral in the small Stephalidæ (fig. 49), dichotomous or irregular in the large Rhodalidæ (figs. 3, 7, 8, 15).

Gonopalpons (Pl. I. fig. 2, *r*; Pl. IV. figs. 15, *r*, 18, *q*; Pl. VI. figs. 37, 38, *q*).—The single form of palpons or tasters, which occur in the Auronectæ, are the sexual palpons or "gonopalpons." Usually (or always?) a single tubular gonopalpon is attached to each cormidium, as a distal branch of its gonostyle; it is a simple cylindrical tube closed at the pointed distal end (fig. 18, *q*). The gonopalpons seem to be very contractile, but were for the most part detached and lost in the specimens examined.

Androphores (Pl. I. fig. 3, *h*; Pl. II. fig. 7; Pl. VII. figs. 46, 49, *h*).—The male gonophores are slender medusoid persons. Their form is more or less cylindrical, sometimes more spindle-shaped, at other times more club-shaped. The basal pedicle, or the male gonocope, is much shorter than the female. The outer envelope, or the umbrella, is very thin walled, often armed at the distal end with four small groups of nematocysts (fig. 46, *uo*). The four radial canals (fig. 46, *hr*), which arise from the peduncular canal and run divergently in the subumbrella, are very narrow and difficult to observe, especially in adult persons; they are connected at the distal end of the umbrella by a small ring-canal (fig. 46, *hc*). The spermarium is formed by the thick-walled cylindrical manubrium. The sperm (fig. 46, *hs*) lies, as usual, between the thin exoderm of the manubrium and its thick entoderm, the axial spadix (*hx*), but separated from the latter by the fulcrum; it has been derived from the exoderm.

Gynophores (*f*). -The female gonophores are much more varied in shape and composition than the androphores. They are easily distinguished from these by their more rounded (usually pear-shaped) form and their longer stalks. There occur the following remarkable modifications:—A. *Monovone gynophores.*—Each female medusome develops only a single large ovum. (1) The gynophore develops a single very large ovum, surrounded by a double envelope; the inner envelope is the thin manubrial wall containing a smaller or larger blind spadicine cavity, sometimes a network of irregular spadicine canals; the outer envelope is the umbrella of the medusoid person, with four narrow radial canals and a small distal ring-canal connecting the latter; this is probably the normal and most frequent form of the ripe gynophore. (2) The same form, but with four blind radial canals (reduced in the distal half). (3) The same form (as 1 and 2), but with eight equidistant regular radial canals (fig. 12). (4) The same form (as 1 to 3), but with a variable number (five to ten) of irregular, branched and anastomosing, spadicine canals. (5) The same form (as 1 to 4), but without radial canals in the reduced umbrella. B. *Polyovone gynophores.*—Each female medusome develops an ovarium, composed of a variable number of ovules, placed in the wall of the modified manubrium. The umbrella seems to be usually reduced, very thin walled, without radial canals; often it has disappeared. (1) The gynophore is a medusome with rudimentary umbrella; the spadicine canal (or the original gastral cavity of the Medusa) is central, straight, and runs in the axis of the manubrium (Pl. II. figs. 9, 10); the ovules are regularly disposed around it. (2) The gynophore is a medusome with rudimentary umbrella; the spadicine canal is excentric, curved, and runs on one side of the manubrium; it embraces the ovarium as a crescent-shaped or semicircular blind canal. (3) The gynophore is a simple sporosac, the manubrium without umbrella; the ovules are arranged equally around the central spadicine canal. (4) The gynophore is a compound sporosac, without umbrella, two or three (rarely more, sometimes only one) buds developing from off the outside of the primary manubrium (Pl. II. fig. 11).

The buds or the secondary sporosacs contain either a single large ovum or a group of several small ovules; they have usually a long pedicle, and its canal arises from the base of the primary spadix.

The different remarkable modifications of gonophores here enumerated, exhibited in the adult spirit specimens examined, showed no regular distribution, but occurred in very variable number and association. A further accurate research on living and well-preserved specimens is required to make out their mutual relations and signification.

Ontogeny.—The development of the Auronectæ is quite unknown, but will probably offer interesting and valuable facts which explain the natural affinities of this interesting order. Among the few spirit specimens of *Stephalia corona* which I discovered in the collection of the "Triton" Expedition (1882), kindly forwarded by Dr. John Murray, two specimens exhibited gonodendra (Pl. VII. figs. 48, 49), whilst a third specimen possessed no trace of them (Pl. VII. figs. 39, 40). A very small medusome, found in the same bottle (Pl. VII. fig. 50), is probably a young larva of this *Stephalia*. This medusome is composed of a pneumatophore (*pa*), an aurophore (*l*), a siphon (*s*), and a simple tentacle (*td*). Unfortunately this larva (*Auronula*) was not well preserved, which prevented further accurate examination.

Synopsis of the Families of Auronectæ.

Trunk of the siphosome with a permanent central canal and a distinct primary mouth.
Tentacles simple, without tentilla, ... 18. Stephalidæ.
Trunk of the siphosome without permanent central canal and distinct primary mouth.
Tentacles branched, with a series of tentilla, ... 19. Rhodalidæ.

Family XVIII. STEPHALIDÆ, Haeckel, 1888.

Stephalidæ, Hkl., System der Siphonophoren, p. 43.

Definition.—Auronectæ with a permanent central canal in the axis of the bulbous trunk, opening at the basal pole by the permanent primary mouth. Tentacles simple, filiform, without lateral branches.

The family Stephalidæ comprises the smaller and inferior forms of Auronectæ, with simple tentacles and a central permanent protosiphon, opening on the basal pole of the vertical axis by a permanent primary mouth. I was able to examine accurately only two genera and species of this interesting family, *Stephalia corona* (Pl. VII.) and *Stephonalia bathyphysa* (Pl. VI.).

The general composition of the corm, the structure of the nectosome and the siphosome, and the form of the single organs composing them, have been described above (p. 281). It is only necessary to add here the remark, that the Stephalidæ, regarded from

a phylogenetic point of view, represent the older and simpler forms of Auronectæ. They resemble the Circalidæ in many respects (Pl. XXI. figs. 1–4); and especially the monogastric *Auronula* (Pl. VII. fig. 50) may be compared to *Circalia*. This latter, however, possesses no trace of the aurophore. The central axial canal of the Stephalidæ (Pl. VII. fig. 40, *ca*) and its distal mouth (*ao*) are of special interest, as comparable on one hand with the terminal protosiphon in the basal cormidium of the Physalidæ, and on the other hand with the central sterile siphon of the Disconectæ. By the thickening of its wall, and the development of anastomosing nutritive canals in this, arises the characteristic trunk of the Auronectæ. Its terminal mouth remains permanently open in the Stephalidæ.

Synopsis of the Genera of Stephalidæ.

Corona of nectophores simple. All tentacles simple, of the same size and form, . . 62*a*. *Stephalia*.
Corona of nectophores double or multiple. A corona of proximal tentacles, annulated, much larger than the simple distal tentacles, ... 62*b*. *Stephonalia*.

Genus 62*a*. *Stephalia*,[1] Haeckel, 1888.

Stephalia, Hkl., System der Siphonophoren, p. 43.

Definition.—Stephalidæ with a simple corona of nectophores, arranged in a single circle. Tentacles simple, all of the same form and equal size.

The genus *Stephalia* (Pl. VII.) is the simplest and oldest (phylogenetically) among the four different genera of Auronectæ which I have examined. Its corona of nectophores is simple, as in *Auralia* and *Circalia* (Pl. XXI. figs. 1–4), all the nectophores being placed in one horizontal plane. The tentacles are simple, cylindrical, not annulated filaments, all of equal size and similar form. The gonodendra (Pl. VII. fig. 49), which, however, in the specimens examined were not fully developed, are smaller than in *Stephonalia*, and seem to want the large gonopalpon characteristic of that genus.

Stephalia corona, n. sp. (Pl. VII.).

Habitat.—North Atlantic, in the depth of the eastern Gulf Stream.

Færoe Channel and Shetland Islands, August 22 and 24, 1882; depth, 640 and 516 fathoms ("Triton" Expedition, Dr. John Murray).

Corm.—Four different specimens of this interesting species were examined by me, all preserved in rather good condition. One of the corms (fig. 39, in profile; fig. 40, in

[1] *Stephalia* = Sea-ring, στέφος, ἅλιος.

sagittal section) was young and immature, the cormidia being without gonophores; but the nectophores (ten in number) attached to the trunk, and the long tentacles (about thirty) attached to the base of the siphons, were rather well preserved. This corm had a length of 10 mm. and a breadth of 6 mm., two other corms (one of which is represented in fig. 48) were somewhat larger and bore a small clustered gonodendron (*g*) on each cormidium; but the nectophores (except one or two) were lost, and the siphons with the tentacles detached; the basal pedicle of the siphons only (*s*) had remained on the trunk. The number of cormidia was forty to fifty. The length of these two corms was 16 to 20 mm., the breadth 10 to 15 mm. The trunk of one corm was similar to that shown in figs. 39 and 40, that of the other relatively smaller (fig. 48). The fourth specimen was the interesting monogastric larva shown in fig. 50 (*Auronula*).

Auronula (fig. 50).—The remarkable larva—only a single specimen of which I could find, after carefully examining the "Triton" collection—had a length of 4 mm. and a breadth of 3 mm.; it represents a single medusome, the modified umbrella of which is the large, flatly spheroidal pneumatophore (*pa*); the manubrium a single large central siphon (*sc*). This protosiphon has a terminal mouth (*ao*), and bears attached to the dorsal side one single tentacle (*td*), and above it a rather large aurophore (*l*). The relatively large size of this, and the full development of its radial structure (*lm*), makes it perhaps probable that the aurophore is not an independent medusoid person (a modified nectophore), but only a separate basal organ of the pneumatophore. Besides some small buds on the ventral side, no other organs were visible in this monogastric *Auronula*. Unfortunately it was not well enough preserved to allow of a microtomic examination.

Nectosome (figs. 39 and 48, lateral view, from the right side; fig. 40, vertical sagittal section).—The superior or apical half of the corm is occupied by the large spheroidal pneumatophore (*p*) and the corona of nectophores (*n*). This is bisected in the sagittal plane by the aurophore (*l*) in the dorsal median line, and by a series of buds (*i*) in the ventral median line. The aurophore is in this species just the same size as each of the nectophores; the number of these is ten to twelve. The structure of the aurophore (*l*) and its axial pistillum (*lm*) is the same as in *Rhodalia* (Pl. V.).

Siphosome.—The inferior or basal half of the corm is occupied by the bulbous trunk of the siphosome and the numerous cormidia attached to its outer surface. The cartilaginous trunk (fig. 40, *a*), pierced by a dense network of anastomosing canals (*ac*), is sometimes subspherical, at other times more like a spindle or a truncated cone. The axial canal (*ca*) is twice as broad as its anastomosing irregular lateral branches, and opens below by the primary mouth. Each cormidium bears a simple tentacle on the dorsal side of the proximal base of the siphon (*s*), and in the mature corms a small gonodendron (fig. 49). This is composed of a single androphore (*h*) and eight to twelve gynophores (*f*). The gonopalpon seems to be rudimentary in this species.

Genus 62*b*. *Stephonalia*,[1] n. gen.

Definition.—Stephalidæ with a double or multiple corona of nectophores, arranged in two or several circles. Tentacles of two different forms and unequal sizes, larger proximal and smaller distal.

The genus *Stephonalia*, represented by the remarkable deep-sea species figured in Pl. VI., is closely allied to the preceding genus, *Stephalia* (Pl. VII.), and was formerly confounded by me with it. But a closer examination and comparison of the two forms showed some peculiar differences between them, which now seem to me to possess a generic value. Firstly, the corona of nectophores, although very incompletely preserved, seems to be composed of two (or even three) circles; and if this be true then *Stephonalia* agrees in this point with *Rhodalia*, and bears to it the same relation as *Stephalia* does to *Auralia* (both with a single circle of nectophores). A second difference between *Stephalia* and *Stephonalia* seems to be in the shape of the tentacles. Whilst these are all quite simple and uniform in the former, they are of two different kinds in the latter. A third difference is found in the development of a large gonopalpon in each cormidium of *Stephonalia*, whilst this seems to be rudimentary in *Stephalia*. Finally, the muscles of the pneumatophore in the latter genus are equally disposed, whilst in *Stephonalia* eight strong radial muscles and corresponding meridional constrictions are marked regularly disposed at equal distances (Pl. VI. fig. 33).

Stephonalia bathyphysa, n. sp. (Pl. VI.).

Habitat.—South Pacific, west of Cook's Strait, New Zealand. Station 166, June 23, 1874; lat. 38° 50′ S., long. 169° 20′ E.; depth, 275 fathoms.

Corm.—Two specimens of this interesting Auronect were found by me in the Challenger collection, both rather well preserved, although very much contracted and altered by the action of the alcohol. The first specimen (fig. 32, seen from the left side in profile; fig. 33, from the dorsal side) was pretty complete, and had a length of 20 mm., a breadth of 16 mm. The second specimen, somewhat larger, but incomplete, had lost the greater part of the nectosome as well as of the siphosome; but the upper third of the latter, with the corona of large-tentacled siphons, was better preserved than in the first specimen; its length was 24 mm., breadth 20 mm. (figs. 34–38).

Nectosome.—The large, flatly spheroidal pneumatophore (figs. 32, 33, *p*) is distinguished by an unusual development of the muscles in its thickened wall. Eight

[1] *Stephonalia*=Small marine corona, στεφάνιον, ἅλιος.

equidistant radial muscles run divergently from the apical centre to the basal periphery, and these are crossed by about a dozen strong circular muscle-rings of equal breadth. The subspherical aurophore (*l*) is about the same size as a nectophore. The number of nectophores in this species, judging from the insertions of their pedicles, may be twenty or thirty, and they seem to be arranged in a double corona, a superior and an inferior. But the majority of the nectophores were detached in the two specimens examined, and a more accurate examination of their arrangement is required.

Siphosome.—The complete siphosome, including the retracted appendages, is nearly spherical, and may be about the same size as the nectosome. The sagittal section is very similar to that of *Stephalia* (Pl. VII. fig. 40); but the central axial canal (*ac*) is wider, and the terminal protosiphon larger (figs. 32, 33, *ap*). The number of cormidia may be sixty to eighty, and they seem to be arranged in a condensed low spiral. The apical part of the trunk is surrounded by a corona of eight larger cormidia, distinguished by very large annulated tentacles, with a slender terminal filament (figs. 34–38). The other cormidia have slender simple tentacles, similar to those of *Stephalia*. Each gonodendron (*g*) bears a large palpon (*q*).

Family XIX. Rhodalidæ, Haeckel, 1888.

Rhodalidæ, Hkl., System der Siphonophoren, p. 43.

Definition.—Auronectæ without a permanent central canal in the axis of the bulbous trunk, and without a permanent primary mouth at its basal pole. Tentacles with a series of tentilla or lateral branches.

The family Rhodalidæ comprises the larger and superior forms of Auronectæ, with branched tentacles, without permanent protosiphon and primary mouth. I was able to examine accurately only a single genus and species of this interesting family, *Rhodalia miranda* (Pls. I.–V.). A second closely allied genus seems to be *Auralia*, differing from *Rhodalia* in the simple corona of nectophores, and in the possession of a large central cavity in the centre of the subglobular trunk of the siphosome. The general composition of the corm, the structure of the nectosome and of the siphosome, and the form of the single organs composing them, have been described above (p. 281). It need only be added here, that the Rhodalidæ, regarded from a phylogenetic point of view, represent the younger and more highly developed forms of Auronectæ. The size of the whole corm, as well as of all its single parts, is far larger, and the number of the cormidia and their component persons and organs far more considerable, than in their ancestral forms, the preceding Stephalidæ. The central axial canal of the latter, and its terminal mouth, have either disappeared, or they cannot be distinguished from the other siphonal cavities and mouth-openings. The tentacles produce a series

of numerous lateral branches or tentilla. The form of the latter, and some other characters of organisation, exhibit some similarity with the Forskalidæ (*Forskalia*, Pls. VIII.–X.).

Synopsis of the Genera of Rhodalidæ.

Corona of nectophores simple. Trunk of the siphosome with a large central cavity, . .	63. *Auralia*.
Corona of nectophores double or multiple. Trunk of the siphosome without large central cavity, ...	64. *Rhodalia*.

Genus 63. *Auralia*,[1] Haeckel, 1888.

Auralia, Hkl., System der Siphonophoren, p. 43.

Definition.—Rhodalidæ with a simple corona of nectophores, arranged in a single circle. Trunk of the siphosome with a wide central cavity, surrounded by a peripheral reticulum of trunk-canals.

The genus *Auralia* may be regarded as the older and inferior form of Rhodalidæ, more closely allied to the preceding Stephalidæ than the succeeding *Rhodalia*. The corona of nectophores is simple, as in *Stephalia*, and the characteristic central canal of the trunk of the latter has left a remainder in the form of a wide central cavity, from which the peripheral network of anastomosing trunk-canals arises. But the basal prostoma (or the primary mouth) has disappeared, and the tentacles bear a series of tentilla, as in *Rhodalia*.

Auralia profunda, the single species of this genus which I have examined, was taken in the depths of the Tropical Atlantic, and will be described afterwards in my Morphology of the Siphonophoræ. Its external appearance is similar to that of *Stephalia corona* (Pl. VII. fig. 39); but the nectophores of the simple corona are more numerous and the tentacles are of the same shape as in *Rhodalia* (Pl. IV. figs. 20–23).

Perhaps belonging to this genus is another Siphonophore, from the depths of the Gulf Stream (1395 fathoms), which Fewkes has described under the name *Angelopsis globosa* (45, pt. xii. p. 972, pl. x. figs. 4, 5), and which he supposes to be a transition form between the Pectyllidæ and the Pneumatophorid (*Physalia*). The nectosome as well as siphosome of this form are subglobular and of nearly equal size. The vertical section (fig. 5) exhibits the flat hypocystic cavity (*cav.*), between the float-cavity (*cav. p*) and the central cavity of the trunk (*cav. b*). The "spherical bag-like structures," which Fewkes supposes to be "budding new individuals" (*grm*), are probably the necto-

[1] *Auralia* = Air-bubble of the sea, αὔρα, ἅλια.

phores. Fewkes' description, however, is so inaccurate, and the examination so superficial, that it is impossible to identify with any certainty his *Angelopsis* and my *Auralia*.

Genus 64. *Rhodalia*,[1] Haeckel, 1888.

Rhodalia, Hkl., System der Siphonophoren, p. 43.

Definition.—Rhodalidæ with a double or multiple corona of nectophores, arranged in two or several circles. Trunk of the siphosome without proper central cavity, traversed by an equal reticulum of trunk-canals.

The genus *Rhodalia*, represented by the wonderful South Atlantic *Rhodalia miranda* (Pls. I.–V.), differs from the preceding *Auralia* in two important characters. The nectosome is similar to that of *Forskalia*, composed of very numerous nectophores, which are not arranged in a simple corona, but in several circles or spiral rows. The trunk of the siphosome is a solid cartilaginous bulb, without central cavity, pierced everywhere by an equally developed network of trunk-canals. *Rhodalia*, therefore, represents the most highly developed genus of Auronectæ.

Rhodalia miranda, n. sp. (Pls. I.–V.).

Habitat.—Western part of the South Atlantic, south-east of Buenos Ayres. Station 320, February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms.

Rhodalia miranda was preserved in rather good condition in the Challenger collection, enclosed in a spirit bottle, the clear spaces of which were filled by horse-hair. Entangled in the latter were found the detached siphons and tentacles of the corms (compare p. 290), whilst the detached nectophores were found in great numbers on the bottom of the vessel. The corms themselves, as well as all their component parts, were very much contracted by the action of the strong alcohol. In the living and fully expanded state they are probably twice the size (or more) shown by the following list of dimensions (p. 303). But the state of preservation, even of the most delicate tissues, was very good, as is seen by comparing figs. 4, 5 (Pl. I.), figs. 7–12 (Pl. II.), and Pls. IV. and V.

Size.—The diameter of the entire corm was in three of the preserved specimens, on an average, between 40 and 50 mm., in the fourth smaller specimen 30 mm. The largest specimen preserved, which is figured in Pls. I. III., twice natural size, gave the following maximum dimensions in millimetres:—

[1] *Rhodalia* = Sea-rose, ῥοδον, ἅλιον.

	mm.
Height of the corm (vertical axis), without nectophores and tentacles,	40
Breadth of the corm (greatest horizontal diameter),	60
Height of the pneumatophore (vertical),	11
Breadth of the pneumatophore (horizontal),	22
Length of the aurophore,	7
Breadth of the aurophore,	6
Length of the nectophores (with pedicles),	20
Breadth of the nectophores (diameter of the umbrella),	10
Diameter of the trunk (vertical and horizontal axes of the siphosome),	30
Length of the siphons (much contracted),	10
Breadth of the siphons (diameter of the stomach),	3
Length of the tentacles (on an average),	200
Breadth of the tentacles,	1
Diameter of the gonodendra,	10
Diameter of the gonophores,	1

Figures.—Figures 1, 6, 13, and 14, which represent the complete corm (1 from above, 6 from below, 13 from the left side, and 14 from the dorsal side), are semi-diagrammatic, inasmuch as the detached nectophores are placed in their probable position and form, and in fig. 13 the detached tentacles are added. Of course the form and position of the detached nectophores could not be recognised in the spirit specimens with full certainty, the soft jelly-substance being much contracted by the action of the alcohol. All the other figures are drawn exactly from the preparations.

Nectosome (Pl. I. fig. 1, apical view from above; Pl. III. fig. 13, superior half, lateral view from the left side; fig. 14, dorsal view from behind; Pl. IV. fig. 15, sagittal section).—The large pneumatophore (*p*) is a flattened spheroid, separated from the subjacent trunk of the siphosome by the flat circular hypocystic cavity (fig. 15, *aa*). The surrounding corona is composed of fifty to eighty (or more) nectophores (*n*), arranged in three alternating annular series (fig. 13); their high lamellar pedicles, however, form a single corona (figs. 14, 16). The corona of the nectosome is perfectly symmetrical, bisected by the vertical sagittal plane; in the ventral centre of this lies the series of buds (Pl. IV. fig. 16, *i*), in the dorsal centre the aurophore (*l*). For the peculiar structure of this latter, compare p. 283, and Pl. V., with explanation.

Siphosome (Pl. II. fig. 6, basal view; Pl. III. fig. 13, inferior half, lateral view from the left side; fig. 14, dorsal view; Pl. IV. fig. 15, sagittal section).—The solid cartilaginous trunk of the siphosome, traversed by a dense network of innumerable canals (fig. 15), is sometimes subspherical, at other times more like a truncated cone. Its entire surface is covered with very numerous, densely aggregated cormidia (fifty to eighty or more). Each cormidium is a conical cartilaginous bulb, and bears a single siphon (*s*) with a very long tentacle (*t*), and a clustered gonodendron; the gonostyle of the latter is originally simple (fig. 3), but often so deeply forked that two separated

gonodendra arise besides the siphon (fig. 2); more rarely three or even four gonodendra arise separately from one cormidium. The long tubular gonopalpon (Pl. I. fig. 2, *r*; Pl. IV. fig. 15, *r*, fig. 18, *q*), as the distal prolongation of the original stem of the gonostyle, seems to be always single in each cormidium.

All the corms examined had lost the nectophores, the siphons, the tentacles, and the gonopalpons, with a few exceptions. All these detached parts were found beside the corms in the bottle. But fortunately in some specimens one or two of these organs had remained in their natural attachment, so that it was possible to determine their probable natural position; so, *e.g.*, a single nectophore (*n*) in Pl. IV. fig. 16, and a single gonopalpon in figs. 2 and 18. All the tentacles were attached to the basigaster of the siphons, which were separated by self-amputation from their pedicles remaining on the trunk (compare above, p. 290). On the structure of all separate parts compare the general description of Auronectæ (pp. 281–296).

Additional Note on the Deep-Sea Life of the Auronectæ.

The new and most interesting group of Auronectæ, which is one of the most splendid discoveries of the Challenger, and described in the preceding pages (pp. 281–304, Pls. I.–VII.), represents a new order which is adapted in a most remarkable manner to deep-sea life. The Auronectæ differ from all other Siphonophoræ in the peculiar structure of the bulbous cartilaginous trunk traversed by a peculiar network of canals, in the singular shortening of the vertical main-axis, and prolongation of the horizontal transverse axis. Upon this vertical depression of the trunk depends the peculiar development of the densely crowded cormidia. But the most striking peculiarity is the extraordinary development of the swimming apparatus, the voluminous pneumatophore, the powerful horizontal corona of radially expanded nectophores, and particularly the singular aurophore, wanting in all other Siphonophoræ, and acting probably as an important gas-secreting gland or a pneumadenia. All these striking characters together make it very probable that the Auronectæ are permanent deep-sea Siphonophoræ, which may move up and down within certain limits of depth, but never come to the surface.

Order V. CYSTONECTÆ, Haeckel, 1888.
(Pls. XXII.–XXVI.)

Pneumatophoridæ, Chun, 1882, **86**, p. 1168.
Cystonectæ, Haeckel, 1888, **95**, p. 44.

Definition.—Siphonophoræ with a large apical pneumatophore, without nectophores and without bracts. Nectosome represented only by the pneumatophore, which always bears an apical stigma. Siphosome either a single cormidium with one siphon (Monogastricæ), or a tubular or vesicular trunk which bears numerous cormidia (Polygastricæ) Gonodendra always monostylic, provided with gonopalpons.

The order Cystonectæ comprises all Siphonanthæ which possess neither nectophores nor bracts, the only organ of swimming being the large apical pneumatophore. They differ in this respect from the three preceding orders, and agree with the Disconanthæ or Disconectæ; but the structure of the float, as well as the entire organisation, is in these latter perfectly different (compare above, pp. 25, 26). We unite in the order Cystonectæ five different families, three of which are new, viz., the monogastric Cystalidæ and the polygastric Epibulidæ and Salacidæ; the two other families, formerly known, and both polygastric, are the Rhizophysidæ (usually united with the Physonectæ) and the Physalidæ; these two families have been united by Chun, in 1882, under the name Pneumatophoridæ (**86**, p. 1168). All known Cystonectæ agree in the complete absence of nectophores and bracts, and in the possession of a large pneumatophore of peculiar structure, provided constantly with an apical stigma for the emission of air. All the genera of this order agree further in the peculiar composition of the monostylic gonodendra, the gynophores of which are detached from the trunk before ripening. In most other respects the Cystonectæ agree generally with the Physonectæ; they may be derived from this order by the loss of the nectophores.

History.—Eschscholtz in his fundamental work (**1**) described, in 1829, three genera and six species of Siphonophoræ which belong to our order Cystonectæ, viz., (1) the Mediterranean *Rhizophysa filiformis*, Lamk. (described already in 1775 by Forskål, **11**, as *Physophora filiformis*), and the closely allied *Rhizophysa planostoma*, Péron (**14**, pl. xxix. fig. 3); (2) the Australian *Epibulia chamissonis* (figured in 1821 by Eysenhardt, **77**, as *Rhizophysa chamissonis*); and (3) the well-known interesting genus *Physalia* with three species (the Atlantic *Physalia caravella*, the Indian *Physalia pelagica*, and the Pacific *Physalia utriculus*). Eschscholtz, as well as most following authors, united these three genera of Cystonectæ with the Physophoridæ (our Physonectæ).

Brandt, in 1835, relying on the excellent (unfortunately hitherto unpublished) figures and descriptions of several new Cystonectæ by Mertens, established for them two different

subfamilies with four genera: (1) the Rhizophysidæ (with *Epibulia* and *Rhizophysa*), and (2) the Physalidæ (with *Alophota* and *Physalia*, **25**, pp. 33, 36). The same two groups were accepted by Huxley, in his Oceanic Hydrozoa, 1859, as two separate families of Physophoridæ (**9**, p. 71).

Physalia, as the largest and most splendid of all Siphonophoræ, well known to all travellers and sailors in the Tropics, celebrated by its peculiar form and swimming locomotion, its brilliant colours and dangerous poison, has provoked a voluminous literature (compare Eschscholtz, **1**, p. 159; Olfers, **79**, p. 26; and Huxley, **9**, p. 93). But the greatest part of it is without scientific value, full of errors, and not supported by accurate researches. Huxley rightly says, that "this department of zoological literature makes one long for the advent of a Caliph Omar, and produces a sort of unpleasant vertigo" (**9**, p. 99). Indeed, the knowledge of *Physalia*, although examined and described by numerous observers, has remained very insufficient up to our time.

I myself had an excellent opportunity of observing living Physalidæ, as well as Rhizophysidæ, during my residence in the Canary Island Lanzerote, in December 1866, and in January and February 1867. Among thousands of large *Physaliæ*, which appeared at Christmas 1866 in the harbour of Arrecife, there were some interesting, crestless, small, new forms, which are figured in Pl. XXVI. of this Report as *Alophota giltschiana* and *Arethusa challengeri*. Pls. XXIII. and XXIV. reproduce the figures of two new genera of Rhizophysidæ (*Cannophysa* with ordinate cormidia, and *Nectophysa* with loose cormidia, both sexually mature), which I had drawn from life in Arrecife in January 1867. But more interesting, as types of new families, may be the two remarkable forms of Cystonects, which I observed in December 1881 and January 1882 in Ceylon, and which are figured in Pl. XXII. as *Cystalia monogastrica* and *Epibulia ritteriana*.

The collection of the Challenger contains a number of *Physaliæ* collected in different parts of the Tropical Atlantic and Pacific, and besides some other Cystonects or fragments of them. Among these is a very interesting deep-sea form, from the Tropical Atlantic (Station 338), *Salacia polygastrica* (Pl. XXV.); it is the type of a new family, intermediate between the Rhizophysidæ and Physalidæ.

Some other interesting new forms of Rhizophysidæ, also inhabitants of the deep sea, were described in 1878 by Studer as different species of *Rhizophysa* (**40**, Taf. i.); they represent, in my opinion, two different genera, *Aurophysa inermis* and *Linophysa conifera*. The large form described by Studer as *Bathyphysa abyssorum* belongs probably to the Forskalidæ (compare p. 248).

Some similar deep-sea forms, described recently by Fewkes (**45**), are too incomplete and too insufficiently known to allow us to recognise their true position in the system.

Recently Chun has given some valuable contributions to our knowledge of the

Cystonectæ. He united in 1882 the Rhizophysidæ and Physalidæ under the name Pneumatophoridæ, and separated them from the Physophoridæ (our Physonectæ) (**86**, p. 1168). He pointed out as a common character the absence of nectophores and bracts, and the peculiar structure of the gonodendra. Chun further published the first accurate description of the peculiar structure of the pneumatophore in the Rhizophysidæ and Physalidæ, and of the metamorphoses of the young *Physalia* (**48**, **83**, pp. 529, 557, 574).

The five different families of Cystonectæ which are described in the sequel, exhibit interesting relations to similar families among the Physonectæ. The monogastric Cystalidæ correspond to the simple Athoridæ. Two polygastric families with a very prolonged tubular trunk have analogous representatives in both orders; the Rhizophysidæ (with monogastric cormidia) are comparable to the Agalmidæ, the Salacidæ (with polygastric cormidia) to the Apolemidæ. Two other polygastric families possess a shortened and inflated vesicular trunk of the siphosome; of these the Epibulidæ are similar to the Discolabidæ, and the Physalidæ in some respects to the Anthophysidæ; the peculiar secondary development of the gigantic pneumatophore, however, and its consequences for their further divergent organisation, remove still more widely the Physalidæ from all other Siphonanthæ.

Nectosome and Siphosome.—The two different main portions of the corm, swimming and feeding portion, exhibit a very different relation in the various Cystonectæ. The nectosome, or the swimming body, is represented only by the large pneumatophore and corresponds to the modified umbrella of the original medusome. The siphosome, on the other hand, exhibits a different shape in the monogastric Cystalidæ, and the polygastric Cystonectæ of the four other families; it is composed in the Cystalidæ (Pl. XXII. figs. 1–5) of a single large siphon (the manubrium of the original medusome), and of various organs budding from its base (a tentacle, a corona of palpons, and a gonodendron). The single siphon of the Cystalidæ corresponds to the axial trunk of the four other families; from its ventral side arise numerous cormidia by budding. These secondary cormidia, composed of siphons, palpons, tentacles, and gonodendra, are sometimes ordinate, at other times loose; they are densely aggregated in the Brachysteliniæ (Epibulidæ, Pl. XXII. fig. 6; and Physalidæ, Pl. XXVI.), with a shortened and inflated vesicular stem; they are loosely scattered and separated by long internodes in the Macrosteliniæ (Rhizophysidæ, Pls. XXIII., XXIV.; and Salacidæ, Pl. XXV.), which possess a long tubular stem. The nectosome and siphosome are usually separated by a constriction corresponding to that portion of the original medusome on which the manubrium is inserted into the centre of the subumbrella. Another structure, differing from that of all other Siphonophoræ, is exhibited by the peculiar Physalidæ. The hypertrophic pneumatophore extends here into the trunk of the siphosome, along its dorsal side, so that this side becomes the superior, and the opposite ventral the inferior side.

Cormidia.—The entire body represents in the monogastric Cystalidæ (Pl. XXII. figs. 1–5) a single cormidium, composed of a large central siphon with a single tentacle, and at its proximal base (beyond the pneumatophore) a corona of palpons, and a single gonodendron. This solitary cormidium is similar to that of the Circalidæ and Athoridæ (Pl. XXI.), but differs in the absence of nectophores and bracts. The four other families are polygastric, and therefore composed of a variable number of cormidia. These are sometimes ordinate, at other times loose. They exhibit a different shape in the two subfamilies of Rhizophysidæ, where the trunk is very long, tubular, and articulate; the cormidia are ordinate and separated by equal free internodes in the Cannophysidæ (Pl. XXIV.), where each cormidium is composed of a single siphon with its tentacle, and a single gonodendron at its base; whereas the cormidia are loose in the Linophysidæ (Pl. XXIII.), where the gonodendra are detached from the siphons, usually alternating with them regularly. The family Salacidæ (Pl. XXV.) is distinguished by polygastric ordinate cormidia; the long tubular stem bearing in regular free intervals numerous equal cormidia, each of which is composed of several siphons (with tentacles) and gonodendra. The shortened vesicular stem of the Physalidæ (Pl. XXVI.) bears clusters of loose cormidia, without regular arrangement; the cormidia of the Epibulidæ, however (Pl. XXII. fig. 6), seem to be ordinate, similar to those of the Discolabidæ.

Pneumatophore.—The hydrostatic apparatus or the swimming-bladder is in all Cystonectæ large, sometimes gigantic and larger than all the other parts of the body together; it is the more important, as it is the only organ of floating, the nectophores being entirely wanting. In *Physalia* it attains unusual dimensions (one or two decimetres and even more), and occupies a far larger volume than in any of the other Siphonophoræ. The general form of the pneumatophore is usually more or less ellipsoidal, ovate or pyriform, sometimes more irregular, oblongish round. Its longitudinal axis is usually not vertical (as in the majority of Physonectæ), but more or less obliquely inclined, and in *Physalia* nearly horizontal. The cavity of the pneumatocyst opens in all Cystonectæ by an apical stigma, or a permanent pore, by which the animal expels the included gas at will, when it will sink down. I have observed this emission of gas repeatedly in the Rhizophysidæ, Epibulidæ, and Physalidæ.

Pneumatocodon.—The outer wall of the pneumatophore, which we call pneumatocodon ("Luftschirm"), is in all Cystonectæ very thick and muscular, and capable of strong contraction. The strongest muscles are the longitudinal or meridional fibres, which lie immediately under the exoderm and diverge from the open apical pole to the equator, and then converge from the latter to the basal pole. They form around the apical stigma a strong musculus dilatator (like that of the pupil of the eye). But further the stratum of circular muscles of the entoderm, which is antagonistic, and separated from the former by the thick fulcrum, is well developed. It forms around the apical stigma a strong sphincter, or a circular musculus orbicularis, which closes its opening completely.

Pneumatosaccus.—The invaginated portion of the apex of the trunk, which forms the air-sac, hangs in all Cystonectæ freely in the pericystic cavity, or the wide interval between the inner and outer wall of the pneumatophore. These two walls are not connected by radial septa, as in most Physonectæ, and are united only on the margin of the apical stigma. The uppermost portion of the air-sac, which surrounds this stigma, is usually intensely coloured (mostly red or brown), or covered by a hemispherical pigment-cap (mitra ocellaris). A ring-like constriction (the pylorus infundibuli, "Trichterpforte") separates incompletely the larger apical and the smaller basal portion of the air-sac. The former is the pericystic sac, which secretes the chitinous pneumatocyst (or the cuticular air-flask); the latter is the hypocystic infundibulum or the pneumatochone (air-funnel, "Lufttrichter"), which together with the tapetum endocystale forms the air-secreting gland, or the pneumadenia. The basal or inferior opening of the pneumatocyst (opposite to the superior or apical stigma) is often surrounded by an annular thickening of the cuticle, the annulus pylori (Pl. XXII. figs. 7, 8).

Pneumadenia.—The exodermal epithelium of the pneumatosac (or strictly speaking of its basal portion), which secretes the gas filling the float, in all Cystonectæ is a gas-gland or pneumadenia of considerable size. It exhibits the simplest shape in the monogastric Cystalidæ (Pl. XXII. fig. 5); it is here a spheroidal vesicle of thickened glandular exoderm, which communicates by a proximal opening (the pylorus) with the cavity of the pneumatocyst; this simple "air-funnel" is very similar to that of the Apolemidæ among the Physonectæ (**50**, Taf. xix. fig. 93). The pneumadenia of the Physalidæ, the largest of all, is originally of the same simple shape as in the Cystalidæ, but expands afterwards unilaterally, on the ventral side of the pneumatophore, and forms there a large circular or oblongish air-secreting plate ("Luftplatte," Chun, **83**, p. 569); in *Caravella maxima* it reaches the extraordinary size of 100 to 150 mm. This peculiar growth along the ventral side of the float is effected by the extraordinary expansion, which the air-sac reaches in the Physalidæ, growing downwards into the cavity of the trunk, along its dorsal side; and by the consequent asymmetrical development.

The three other families (Rhizophysidæ, Pls. XXIII., XXIV.; Salacidæ, Pl. XXV.; and Epibulidæ, Pl. XXII. figs. 6–8) agree in a peculiar structure of the pneumatophore and differ essentially from the two preceding (Cystalidæ and Physalidæ). The beginning of the structure is the same as in the latter; but afterwards the pneumadenia exhibits a further very remarkable development, firstly in the endocystic tapetum, and secondly in the hypocystic villi. The glandular exodermal epithelium of the primary spheroidal pneumadenia (or the air-funnel) grows in apical direction, passes through the pylorus into the cavity of the pneumatocyst, and expands into its basal portion, lining its inside (in younger floats only one-third, in older more than two-thirds). The extraordinary development of the gas-gland in these Cystonectæ corresponds to its important physio-

logical function, since these Siphonophoræ, which have no nectocalyces, descend into the depths of the ocean by expelling the gas, and ascend again by secreting gas and filling the float. We call this important new portion of the pneumatosac, which lines the inside of the air-flask (excepting its apical portion), tapetum endocystale ("Secundacres exoderm," Chun, **48**, pp. 514, 530).

Hypocystic Villi.—The second peculiarity which distinguishes the air-sac of the Rhizophysidæ, Salacidæ, and Epibulidæ, is the production of peculiar hypocystic villi (Pl. XXII. figs. 6–8, *pv*; Pl. XXIV. figs. 1–6, *pv*; Pl. XXV. figs. 1–3, *pv*). These remarkable apophyses of the air-funnel were first described in the Mediterranean *Rhizophysa filiformis* by Gegenbaur (**7**, p. 44, Taf. xviii. fig. 6, *e*) and by Huxley (**9**, p. 6, pl. viii. figs. 14, 15); they occur not only in all Rhizophysidæ, but also in *Salacia* and *Epibulia*. From the hypocystic air-funnel, beyond the pylorus, arise eight radial bunches of clustered villi, which fill up the basal portion of the pericystic cavity, often more than half of it. The single villi, or the finger-shaped branches of the clustered bunches, are composed of a single or a few gigantic exoderm-cells (1 to 2 mm. in diameter) and of a ciliated epithelium of small entoderm-cells. Their function is probably mechanical, as an elastic cushion to protect the delicate pneumadenia and prevents its sudden compression. (Compare below the description of the float in the Rhizophysidæ, and also Chun, **47**, p. 464; **48**, p. 529.)

Siphons.—The feeding polypites or siphons in all Cystonectæ are relatively large, often of an extraordinary size. The four different segments of the siphon, which we could distinguish in most Physonectæ and Calyconectæ (pedunculus, basigaster, stomachus, proboscis), are also recognisable in many Cystonectæ, as in *Cystalia* (Pl. XXII. fig. 5) and *Salacia* (Pl. XXV. fig. 5). They are not distinguished, or at least not sharply separated, in most Rhizophysidæ, where usually each siphon is a simple cylindrical or fusiform tube, distally contractile and protractile, with strong muscular wall (Pl. XXIII. figs. 1, 2, 5; Pl. XXIV. figs. 1–3, *s*). Probably in all Cystonectæ the stomach, or the digestive middle part of the siphon, bears inside numerous hepatic villi, sometimes arranged in longitudinal series; but rarely there occur continuous hepatic striæ, as in *Linophysa*. The glandular villi are often coloured brown or black by pigment-granules, especially in the Physalidæ (Pl. XXVI. fig. 6, *sv*). The stomach in these and in other Cystonectæ is rather distinctly separated from the proboscis, or the distal part of the siphon, without villi, with thickened muscular wall. Its distal mouth-opening may be expanded in the form of a large suctorial disc, usually of circular, more rarely of polygonal or quadrangular form. The basigaster or the basal cavity (Pl. XXVI. fig. 6, *sb*) is usually not separated from the stomach by a pyloric valve, and its exoderm is not strongly thickened; it passes over into the peduncle without a sharp boundary, and often this latter part is scarcely distinguishable. But sometimes the peduncle of the siphon is rather long and thin (*bp*). The monogastric Cystalidæ (Pl. XXII. figs. 1–5) possess only a single large siphon. All other Cystonectæ

are polygastric. The macrostelial Rhizophysidæ (Pls. XXIII., XXIV.) bear a single siphon in each cormidium, as also do the brachystelial Epibulidæ (Pl. XXII. fig. 6). The Salacidæ exhibit a bunch of several siphons in each cormidium (Pl. XXV. figs. 1–4). The Physalidæ, finally, bear on the ventral side of the shortened vesicular stem a crowded group of numerous loose and polygastric cormidia, with a large number of clustered siphons; often larger and smaller polypites intermingled and arising from a common pedicle, but the smaller Physalidæ (*Alophota*, Pl. XXVI. figs. 2, 3), and the young forms of the larger species, bear on the ventral side of the trunk a simple series of ordinate monogastric cormidia.

Protosiphon.—In many Cystonectæ (or perhaps in all?) the primary manubrium of the larval medusome remains functional as the "primary feeding polypite," or the protosiphon. It is the single siphon in the Cystalidæ. In all young Physalidæ the protosiphon, placed at the basal pole of the inflated trunk and opposed to the apical stigma, forms an independent cormidium (Pl. XXVI. figs. 2, 3, *su*); originally it is separated by a wide interval from the ventral group of the secondary cormidia, which arise on the ventral side of the trunk, and bear the metasiphons (or the secondary polypites). The latter alone afterwards produce gonodendra, not the former. So also in the Epibulidæ the protosiphon seems to remain as the basal siphon at the distal end of the trunk. Its comparison with the manubrium of the primary medusome, or the larva of the Cystonectæ (*Cystonula*, Pl. XXII. figs. 1–4; Pl. XXVI. fig. 1), shows us that the axial trunk of the polygastric corms is only the basal part of the modified protosiphon, widely inflated in the Brachysteliniæ, extremely prolonged in the Macrosteliniæ.

Palpons.—All Cystonectæ possess a great number of palpons (tasters, hydrocysts, or mouthless polypites). These are usually cylindrical or spindle-shaped tubes with a very contractile muscular wall, and a pointed and closed distal apex, often coloured. They occur in three different forms, as sexual palpons, coronal palpons, and tentacular palpons.

Gonopalpons or *Sexual Palpons* are generally distributed, occurring in the gonodendra scattered between the gonophores. Sometimes each branch of the clustered gonodendron bears a single gonopalpon (Pl. XXIII. fig. 8, *gq*); at other times several palpons (Pl. XXV. fig. 7, *gq*); those of the Physalidæ (Pl. XXVI. fig. 8, *q*) are distinguished by the possession of hepatic villi, which prove evidently that they are merely mouthless siphons.

Coronal Palpons occur only in two families of Cystonectæ, in the monogastric Cystalidæ and the polygastric Epibulidæ (Pl. XXII. figs. 5, 6). They form a corona around the base of the siphosome, beyond the pneumatophore, similar to that of the Discolabidæ and Anthophysidæ (Pls. XI., XIX.). As in these latter, the coronal palpons are not only organs of feeling and capturing, but also of protecting, and replace the absent bracts. Their pointed distal end is armed with cnidocysts.

Tentacular Palpons are peculiar to one family only, the Physalidæ (Pl. XXVI. figs.

3–6, *to*), where each tentacle does not arise from the base of a siphon (as is usually the case in the Siphonanthæ) but from the base of a large palpon, which is connected by a common pedicle only with the base of the siphon. Huxley, therefore, calls these palpons not hydrocysts, but basal sacs of the tentacles (similar to the ampullæ of the ambulacral feet in Echinoderms). It may be that these basal ampullæ are only secondary diverticula of the base of the tentacle, and have the morphological value of a subordinate organ. On the other hand, it is possible that each cormidium of the Physalidæ originally bore two polypites each with a tentacle; one of these (the siphon) has preserved the mouth and the hepatic villi, but lost the tentacle; the other, conversely, has lost the former organs and preserved the latter (the palpon).

Tentacles.—The capturing filaments are arranged in the majority of Cystonectæ in the same manner as in all other Siphonanthæ, a single tentacle arising from the basal pedicle of each siphon. A single exception is formed by the Physalidæ, in which the tentacles arise from the base of peculiar palpons, as has just been mentioned (Pl. XXVI. figs. 2–6). The tentacles are generally long and vigorous, very muscular tubules, sometimes simple, at other times branched. They are simple, not branched filaments in the genera *Linophysa* (Rhizophysidæ) and *Salacia* (Salacidæ), and in all Physalidæ. In all the other genera the tentacles are branched, and bear, usually, a single series of equidistant tentilla or lateral filaments. These latter are simple thin tubules, beset with scattered cnidoblasts in the genera *Cystalia*, *Epibulia* (Pl. XXII.), *Aurophysa*, and *Nectophysa* (Pl. XXIII.). The distal end of the tentillum is trifid (with a terminal ampulla and a pair of lateral horns) in the genera *Cannophysa* (Pl. XXIV.) and *Pneumophysa*. The genus *Rhizophysa* is distinguished by the possession of two or three different kinds of tentilla; between the trifid forms being intermingled peculiar large hand-shaped or palmate tentacles which bear an ocellus.

The cnidocysts of the tentacles are spherical in most Cystalidæ (Pl. XXIII. fig. 7), and do not exhibit that variation in form seen in the Physonectæ. Their arrangement is variable in the various groups. Usually each tentillum bears a multiple series of cnidocysts on its dorsal side whilst the opposite ventral side is covered with palpoblasts (Pl. XXIII. fig. 6, *tw*). The simple tentacles of the Physalidæ (Pl. XXVI. fig. 6, *t*) and of the Salacidæ (Pl. XXV. fig. 5, *t*) bear a long series of large reniform cnidonodes on their dorsal side (compare Huxley, 9, pl. x. figs. 11, 12, &c.). Each cnidonode embraces the tentacle with the concave ventral side, and bears on the convex dorsal side a cushion of cnidocysts. They develop in the same manner as the tentilla of branched tentacles and contain a cavity, as a diverticulum of the tentacular canal. Each kidney-shaped cnidonode, therefore, may be regarded as a very short and broad tentillum.

Gonophores.—All Cystonectæ possess monœcious corms, monoclinic cormidia, and monostylic gonodendra, male and female gonophores arising from the same branched gonostyle. The peculiar form and composition of the clustered gonodendra seems to be

the same in all members of this order. The stem of the gonostyle is always richly ramified, and bears on each branch one or several sexual palpons (*gq*), a single gynophore or female medusome (*f*), and a great number of androphores or male medusomes (*h*). These latter become mature whilst attached to the gonodendra; they have ovate or club-shaped spermaria, with a more or less rudimentary umbrella (Pl. XXIII. fig. 8, *h*; Pl. XXV. fig. 7, *h*; Pl. XXVI. fig. 8, *h*).

The larger female gonophores, however, are probably always detached in the immature state from the stem, and become mature as free Anthomedusæ. Their umbrella (*f* in the figures quoted) is well developed, campanulate or pyriform, with four radial canals and a ring-canal, and a broad velum around the ostium. The manubrium, in the wall of which the eggs ripen, seems to be developed usually after the detachment. It is not visible in the sessile gynophore, or forms only a small tubercle in the centre of the subumbrella (Pl. XXIII. fig. 8, *fm*). The apex of the gynophore is attached to the branch of the stem by a large conical pedicle (Pl. XXIII. fig. 8, *f*). These pedicles remain attached to the stem of the gonodendron, when the ripe gynophores are detached. Some very large specimens of *Caravella maxima*, which I observed in the Bay of Algesiras (Straits of Gibraltar), in March 1867, bore voluminous gonodendra, the androphores of which were filled with ripe sperm. Some of their numerous branches possessed each a single medusiform gynophore (Pl. XXVI. fig. 8, *f*), whilst in other branches only its conical pedicle was visible, the campanulate umbrella having been detached (compare Chun, **86**, p. 1168).

The Cystalidæ, Epibulidæ, and Rhizophysidæ seem to possess on each branch of the gonostyle a single sexual palpon only, corresponding to the single gynophore (Pl. XXIII. fig. 8); whilst the Salacidæ and Physalidæ bear several gonopalpons on each branch. The gonopalpons of the Physalidæ are covered inside by the same black hepatic villi as the siphons, and thus prove to be modified mouthless siphons (Pl. XXVI. fig. 8, *q*). The sexual tasters of the Rhizophysidæ are often covered outside with peculiar cnidonodes (Pl. XXIII. fig. 8, *gq*).

Ontogeny.—The development of the Cystonectæ from the *fertilised* egg is up to this time quite unknown. The ripe eggs themselves have never been observed. The medusiform gynophores are detached early from the trunk, and the special forms of Anthomedusæ, in which they produce ova, are not yet known. Very little is known also of the monogastric larvæ of the Cystonectæ (*Cystonula*), and of their peculiar metamorphosis. Those of *Physalia* were first described by Huxley (**9**, p. 102, pl. x. figs. 1, 2) and afterwards by Chun (**83**, p. 558). The Cystonula of the other families is hitherto unknown. Some light, however, may be thrown upon this complete darkness by a number of larval forms which I captured by means of the tow-net in December 1881, in Ceylon, and which are figured in Pl. XXII. figs. 1–4. Compare their description below, under that of the family Cystalidæ (p. 315).

Synopsis of the Families of Cystonectæ.

I. Suborder CYSTONECTÆ MONOGASTRICÆ (MONOSTELINIÆ).

Corm with a single large siphon, representing one cormidium only. A single tentacle on the base of the siphon. A corona of palpons around the base of the large pneumatophore. Pneumatosac without hypocystic villi, ... 20. Cystalidæ.

II. Suborder CYSTONECTÆ POLYGASTRICÆ.

Corm composed of numerous cormidia, each with one or more siphons and tentacles. Cormidia sometimes ordinate, at other times irregular. (Primary larva monogastric, *Cystonula*.)

A. MACROSTELINIÆ.

Trunk of the siphosome very long and thin, tubular, with prolonged internodes.

- Cormidia monogastric, each with a single siphon and tentacle. (Pneumatosac with hypocystic villi), . 21. Rhizophysidæ.
- Cormidia polygastric, each with several siphons and tentacles. (Pneumatosac with hypocystic villi), . 22. Salacidæ.

B. BRACHYSTELINIÆ.

Trunk of the siphosome short and wide, vesicular or bag-shaped, with shortened internodes.

- Cormidia in a spiral corona around the vesicular trunk, beyond the base of the subvertical pneumatophore (with hypocystic villi), . 23. Epibulidæ.
- Cormidia in a multiple series along the ventral side of the trunk, the dorsal side of which is occupied by the subhorizontal pneumatophore (without hypocystic villi), . . . 24. Physalidæ.

Family XX. CYSTALIDÆ, Haeckel, 1888.

Cystalidæ, Hkl., System der Siphonophoren, p. 44.

Definition.—Cystonectæ monogastricæ, with a single large siphon and a single tentacle on the base of the large apical pneumatophore. Base of the siphon surrounded by a corona of palpons. Pneumatosac simple, without radial septa and hypocystic villi.

The family Cystalidæ comprises a single new genus of small, but very remarkable Cystonectæ, which differs from all other genera of this order in the monogastric structure of its corm. This interesting genus, *Cystalia* (Pl. XXII. fig. 5), exhibits therefore a relation to all the other polygastric Cystonectæ similar to that which the monogastric *Circalia* or *Athoria* (Pl. XXI.) bears to the polygastric Physonectæ.

During my residence in Ceylon I captured by the tow-net several times the elegant form, which I called in my System (**95**, p. 44) *Cystalia larvalis*. A very similar, and perhaps identical, form was found in a bottle of the Challenger collection, from Station 288 (centre of the Southern Pacific); I named it there *Cystalia challengeri*. A closer comparison of them makes it very probable that these two species are identical; the more significant name *Cystalia monogastrica* may, therefore, be retained for both.

At the first glance I had supposed that *Cystalia larvalis* might be only a young form

or a monogastric larva of the polygastric *Epibulia ritteriana* (Pl. XXII. figs. 6–8). Indeed it is possible that this latter has been developed immediately from the former, or that *Cystalia* is a larva of *Epibulia*, which has reached sexual maturity only exceptionally (Pædogenesis). But comparing the structure of the pneumatophore in both similar forms, we find that the polygastric *Epibulia* possesses the eight radial clusters of hypocystic villi characteristic of the Rhizophysidæ, whilst these are wanting in the monogastric *Cystalia*. In any case the fully developed state of the gonodendron in the latter justifies its position as an independent genus.

In the same month (December 1881) in which I captured *Cystalia larvalis* off the coast of Ceylon, I took by the tow-net a number of young larvæ of Siphonanthæ, which I supposed at the first glance to be the larvæ of some Physonect, perhaps an Agalmid. The most important stages of them are figured in Pl. XXII. figs. 1–4. Comparing them with the larvæ of the Agalmid *Cupulita*, which Metschnikoff has described as *Stephanomia pictum* (**85**, Taf. xii.), we find a great likeness between these larvæ. The youngest larva observed (fig. 1) exhibits a spindle-shaped gastrula, composed of a large-celled entoderm (*d*) and a small-celled ciliated exoderm (*e*), with the invagination of the pneumatophore on the apical pole. In the second stage (fig. 2) the medusiform body is divided by a transverse annular constriction into a proximal and a distal portion; the superior portion is the rudimentary umbrella with the pneumatophore (already containing a gas-bubble); the inferior portion is the primary siphon, from the base of which arises a single tentacle. In the third stage (fig. 3) the distal mouth of the siphon is open, and from its base, opposite to the dorsal tentacle, arises in the ventral side the first bud (*i*), probably of a palpon. The fourth and last stage observed (fig. 4) exhibits the number of buds augmented (as the beginning of a corona of palpons ?), and the single tentacle beset with a series of simple filiform tentilla (*ts*).

Since I was not able to recognise the origin of these pelagic larvæ, nor to follow their further development, the question remains open, whether they were produced by a Physonect or a Cystonect. In the latter case they may possibly have been derived either from *Cystalia* or from the closely allied *Epibulia*.

Cormidium.—The central or axial portion of the single cormidium, which represents the entire adult corm of *Cystalia*, must be regarded as an individual medusome, the modified umbrella of which is the pneumatophore (*p*) and the manubrium the siphon (*s*). The base of this latter bears a single tentacle on its dorsal side, a single large gonodendron (*gd*) on its ventral side. The short tubular pedicle of the siphon which connects it with the base of the float represents the axial trunk of the corm, and has produced by budding the corona of palpons, which are expanded between them. The gonodendron itself is the sexual portion of the single cormidium, composed of numerous male and female gonophores, each of which is a modified medusome.

Comparing the single parts of the corm with the similar parts of related Siphono-

phoræ, we find resemblances to different families. The pneumatophore resembles by its simple structure that of the Athoridæ and Apolemidæ, and that of the young Physalidæ (*Alophota*, Pl. XXVI. figs. 1, 2); the pericystic cavity is simple and has not the radial pouches of most Physonects, nor the hypocystic villi of the Rhizophysidæ and Epibulidæ. The corona of palpons between float and siphon is similar to that of *Epibulia* (Pl. XXII. fig. 6), and also to that of the Discolabidæ and Anthophysidæ. The single tentacle, with its series of simple filiform tentilla, resembles that of *Epibulia* and *Nectophysa* (Pl. XXII. figs. 5, 6). The structure of the single siphon, with its hepatic villi, and of the monoclinic gonodendron, is the same as in the Rhizophysidæ and Physalidæ.

Genus 65. *Cystalia*,[1] Haeckel, 1888.

Cystalia, Hkl., System der Siphonophoren, p. 44.

Definition.—Cystalidæ with a tentacle, which bears a series of simple filiform tentilla. A single large monostylic gonodendron is attached to the base of the single siphon.

The genus *Cystalia*, as the only known form of monogastric Cystalidæ, exhibits the peculiar structure described above of this family. Supposing that other genera, belonging to it, may sometimes be observed, we assume as a generic character of *Cystalia* the structure of the single tentacle, which is similar to that of *Aurophysa*, *Nectophysa*, and *Epibulia*. It bears a series of simple lateral branches, which remain cylindrical filaments, without terminal appendages. On the medusiform larvæ (*Cystonula*, Pl. XXII. figs. 1–4), which may perhaps belong to this genus, compare p. 315.

Cystalia monogastrica, n. sp. (Pl. XXII. figs. 1–5).

Cystalia larvalis et *Cystalia challengeri*, Hkl., 95, p. 44.

Habitat.—South Pacific; Station 288, October 21, 1875; lat. 40° 3′ S., long. 132° 58′ W.; surface.

Indian Ocean, Ceylon, Belligemma, December 1881 (Haeckel).

Corm (fig. 5).—The monogastric corm, represented in fig. 5 in the expanded state, has a length of 10 to 12 mm. It is to be regarded as a single cormidium, composed of a sterile axial medusome and two groups of peripheral medusomes, sterile palpons and fertile gonophores. The large axial medusome consists of a pyriform pneumatophore and a large spindle-shaped siphon, with a single tentacle; the siphon corresponds to the manubrium, and the float to the modified umbrella of the original Medusa. The short pedicle of the siphon, which connects it with the base of the float, may be regarded as the axial trunk of the corm, from which the corona of palpons as well as the large ventral

[1] *Cystalia* = Sea-bladder, κύστη, ἅλια.

gonodendron are produced by budding. Each branch of the gonostyle is a secondary cormidium, composed of a sterile distal palpon, a large female medusome, and a group of clustered small male medusomes.

Pneumatophore (fig. 5, *p*).—The float is pyriform, 3 mm. long and 2 mm. broad, with a red pigment-cap in the apical third. The enclosed pneumatocyst is subspherical, 1·2 to 1·5 mm. in diameter; it fills the upper or apical portion of the air-sac, which is separated by an annular diaphragm (pylorus infundibuli) from the spheroidal lower or basal portion, the air-funnel. This is lined by the greenish hypocystic tapetum, which also enters by the pylorus into the cavity of the air-flask and lines its basal third as endocystic tapetum. No radial septa or villi arise from the air-funnel.

Siphon (fig. 5, *s*).—The single siphon of the monogastric cormidium is spindle-shaped, 6 to 9 mm. long and 2 to 3 mm. broad. Its ampullaceous basal portion (basigaster) is attached by a short pedicle to the base of the pneumatophore. The dilated middle portion, or the stomach, is covered inside with numerous yellowish-brown hepatic villi (*sh*). The thin tubular proboscis (*sr*) is very muscular and opens by a mouth, which may be expanded in the form of a circular suctorial disc (*ss*).

Tentacle (fig. 5).—The single tentacle (*t*) which arises from the base of the siphon, on its dorsal side, is a slender cylindrical tube, beset with a series of tentilla. These are simple cylindrical filaments, and bear on their dorsal side a multiple series of cnidocysts; the structure is similar to that of *Nectophysa* (Pl. XXIII. figs. 5, 6).

Palpons (fig. 5).—The corona of rose-coloured tasters which protects the siphosome is attached to its base, immediately beyond the nectosome. It is composed of about thirty spindle-shaped palpons, besides the small buds of young ones. Their pointed distal end is closed, whilst the proximal end of their cavity communicates with the pedicular canal of the siphon.

Gonodendron (fig. 5, *gd*).—The single large clustered gonodendron, which is attached to the base of the siphon, on its ventral side, is similar to that of the Rhizophysidæ. The gonostyle is richly branched, and each ultimate branch bears a single gonopalpon on its distal end (Pl. XXIII. fig. 8, *gq*), and above it a single medusiform gynophore (*f*) and a cluster of several (four to eight) ovate androphores (*h*).

Family XXI. Rhizophysidæ, Brandt, 1835.

Rhizophysidæ, Brandt, Prodromus descriptionis, &c., **25**, p. 33.

Definition.—Cystonectæ polygastricæ, with a long tubular trunk of the siphosome, bearing in its ventral median line numerous monogastric cormidia, separated by free internodes. Each cormidium with a single siphon and a single tentacle. Pneumatosaccus large, without radial septa and pericystic radial pouches, but with eight or more radial groups of hypocystic villi.

The family Rhizophysidæ comprises all Cystonectæ polygastricæ with a long tubular stem, bearing numerous monogastric cormidia. The trunk of the corm is a prolonged and very contractile tube, as in the succeeding Salacidæ; but the cormidia of these latter are polygastric. Many different species, and mainly deep-sea forms of gigantic size, seem to belong to this interesting family; but only a few species have been described hitherto with sufficient accuracy. All species have been united up to this time in a single genus, *Rhizophysa*.

The oldest known form of Rhizophysidæ is the Mediterranean *Rhizophysa filiformis*, described as early as 1775 by the first author on Siphonophoræ, Forskål, under the name *Physophora filiformis* (**11**, p. 120, Tab. xxxiii. fig. F). A similar species from the Atlantic was figured in 1807 by Péron and Lesueur under the name *Rhizophysa planostoma* (**14**, pl. xxix. fig. 3). A third species of the same genus was observed in 1827 by Mertens in the Northern Pacific, and described by Brandt in 1835 as *Epibulia mertensii* (**25**, p. 33). Unfortunately Mertens' excellent figure, drawn from life and exhibiting distinctly the characters of the genus *Rhizophysa*, has never been published. Brandt established for these forms the family Rhizophysidæ (*loc. cit.*, p. 33).

The first accurate anatomical description was that given in 1854 by Gegenbaur of the Mediterranean *Rhizophysa filiformis* (**7**, p. 324; **10**, p. 78). It was afterwards supplemented by Huxley (**9**, p. 90), Fewkes (**41**, p. 292), and especially by Chun (**47**, p. 404; **48**, p. 529; **86**, p. 1169). Two new genera of this family, *Cannophysa* and *Nectophysa* (Pls. XXIII., XXIV.), were observed by me in 1866 off the Canary Islands. Two other genera, *Aurophysa* and *Linophysa*, both inhabiting the deep sea, were described in 1878 by Studer as species of *Rhizophysa* (**40**, p. 4, Taf. i.).

Truncus.—The common stem of the corm is in all Rhizophysidæ a very long and slender cylindrical tube; its contractility is so great that, in the expanded state, it may be ten to twenty times as long as in the contracted state (compare Pl. XXIII. figs. 1–3 and Pl. XXIV. figs. 1–3). At the same time it is so sensitive that a slight touching of the stem is sufficient to effect suddenly its strongest contraction. The wall of the tubular trunk is rather thick, with a thin layer of circular muscles arising from the entoderm, and a thick layer of longitudinal muscles arising from the exoderm; the latter are arranged, as usual, in parallel bundles along the radial folds of the fulcrum, which separates the two layers. The exoderm is often coloured yellowish, rose, or brown.

Cormidia.—The numerous cormidia, which arise from the long tubular stem of the corm, exhibit in the Rhizophysidæ (as in the Agalmidæ) a double shape and arrangement, according to which two subfamilies may be separated, the Cannophysidæ and Nectophysidæ. The Cannophysidæ (Pl. XXIV.) possess ordinate cormidia, which are separated by long, free, and naked internodes of equal length (similar to those of the Stephanomidæ); each cormidium is composed of a siphon, a tentacle, and a gonostyle;

this latter is branched and bears numerous clustered gonodendra, each of which is again composed of a gonopalpon, a large female gonophore, and a variable number of smaller male gonophores. The Nectophysidæ, on the other hand (Pl. XXIII.), have loose cormidia (similar to those of the Halistemmidæ); the gonostyles are not attached to the trunk at the basal insertion of the siphons, but separated from them on the internodes; sometimes a single gonodendron in the middle between each two siphons (*Nectophysa*, &c.), at other times two to four or more gonodendra.

Pneumatophore (Pl. XXIII. figs. 1–4, *p*; Pl. XXIV. figs. 1–7, *p*).—The float filled with air is in all Rhizophysidæ relatively large, much larger than in the Physonectæ; its form is variable, usually ovate, ellipsoidal or pyriform. Its central axis is sometimes vertical, usually more or less inclined, at other times almost horizontal. The pneumatocodon, or the outer wall of the float (*p*), is separated from the pneumatosaccus, or the inner wall, by a wide cavity, which often occupies nearly the half of the pneumatophore, or even more. This pericystic cavity is closed above (where the two walls of the float are connected on its top), and opens below into the axial canal of the trunk; its greater part is filled up by clusters of large branched villi, the radial apophyses of the pneumadenia.

Pneumatosaccus.—The invaginated part of the exoderm, which we call pneumatosac, hangs freely in the pericystic cavity, and is not connected with it by radial septa (as in most Physonectæ). It is connected with the pneumatocodon only at its top, where it opens by the apical stigma (*po*). The simple wall of the young pneumatosac (comparable to the invaginated entoderm of a gastrula) is divided in the adult Rhizophysidæ into five different parts, viz.:— (1) A mitra ocellaris or an apical pigment-cap; (2) the pericystic sac, enclosing the air-flask; (3) the hypocystic funnel; (4) the hypocystic radial bunches of villi arising from the funnel; and (5) the endocystic tapetum ("secondary exoderm"). This latter lines the greater part of the inside of the chitinous pneumatocyst.

Pneumatocyst.—The chitinous air-flask or pneumatocyst is originally the cuticle of the young pneumatosac. It is ovate, spindle-shaped or cylindrical, and opens at both poles of its longitudinal axis; the inferior opening is the pylorus infundibuli, which leads into the funnel-cavity of the pneumadenia; the superior opening is the apical stigma, through which the air may be emitted at will from the cavity of the pneumatocyst (Pl. XXIII. fig. 3, *x*). This stigma, or the apical opening of the float (Pl. XXIV. figs. 4, 5, *po*), may be opened by a corona of radial muscles (*pn*) and closed by a sphincter composed of ring-muscles (*pm*).

Mitra ocellaris.—The pigment-cap of the float, or the mitra ocellaris (Pl. XXIII. fig. 3, *pp*; Pl. XXIV. figs. 4, 5, *pp*), occupies sometimes nearly the upper half, at other times only the uppermost third or fourth of the pneumatosac, and is composed of elegant polygonal pigment-cells, separated by colourless intervals. The colour is usually red or

brown, sometimes more orange, at other times more violet or even black. The inferior margin of the hemispherical or campanulate pigment-cap is usually separated by a sharp circular boundary-line from the colourless or yellowish middle portion of the air-sac (Pl. XXIV. fig. 5, *pp*).

Sacculus pericystalis.—The greater middle part of the pneumatosac is a simple layer of exodermal epithelium, and produces the pneumatocyst as a true cuticle; it ends, together with this latter, on the *pylorus infundibuli*, or the opening by which the air-flask communicates with the funnel-cavity; the terminal edge of the cuticle which surrounds this circular pylorus is usually a thickened chitinous ring (*annulus infundibuli*).

Pneumatochone (infundibulum pneumatophori, "Lufttrichter," Chun, **48**, p. 512).—The distal or basal part of the original pneumatosac situated below the pylorus is the important pneumatochone or the "hypocystic funnel." The thickened glandular epithelium which lines its cavity is very different from that of the pericystic sac. It produces no cuticle, but is composed of several layers of polyhedral exoderm-cells, which have a rather dark granular protoplasm and a peculiar yellowish or more greenish appearance (Pl. XXIV. fig. 7). From this ovate, hemispherical, or nearly spheroidal "air-funnel" arises inside, the endocystic tapetum, and outside, the clustered groups of hypocystic villi (Pl. XXII. fig. 7).

Tapetum endocystale ("secondary exoderm," Chun, **48**, pp. 514, 530).—The exodermal tapetum which lines inside the basal half of the pneumatocyst (in young Rhizophysidæ the basal third, in adult more than two-thirds) is the direct continuation of the hypocystic funnel, and its function is, like that of the latter, the secretion of gas; both together represent the "pneumadenia," or the gas-secreting gland. The stratified exoderm of the air-funnel grows upwards, passes through the chitinous ring of the funnel-pylorus into the cavity of the pneumatocyst and lines the greater part of its inside, with the exception of the apical part which is covered by the mitra ocellaris. The endocystic tapetum is composed of several strata of the same peculiar granular and yellowish or greenish exoderm-cells, as those which line the funnel-cavity and are polyhedral by mutual compression (Pl. XXII. fig. 7, *pd*; Pl. XXIV. fig. 7, *pd*).

Villi hypocystales (Pl. XXIV. figs. 4, 5, *pv*, 6).—The basal portion of the pericystic cavity, and often its greater part (with the exception of the apical portion), is filled with bunches of clustered villi, which arise from the outside of the hypocystic funnel. They were first described by Gegenbaur (in 1854) as "cæcal diverticula" of the pneumatocyst ("blinddarmähnliche Fortsätze," **7**, p. 326, Taf. xviii. fig. 6, *e*). Huxley (in 1859) described them as "elongated and more or less branched processes, which project from the distal surface of the pneumatocyst freely into the cavity of the pneumatophore; each process consists of a cellular axis, invested by the ciliated entoderm. The cells of the axis are clear and very large, and have an opaque oval

nucleus" (**9**, p. 6, pl. viii. figs. 14, 15). This good description of Huxley was not improved by later authors, who regarded the hypocystic villi as tubes or utriculi. Fewkes (in 1882) describes them as "finger-like pouches, which are sometimes bifurcated at their extremities and open at their distal ends, so that their cavities seem to freely communicate with that of the float" (**44**, p. 269, pl. vi. fig. 2). The most accurate description was afterwards given by Chun, who regards their physiological function as mechanical; they may serve as elastic cushions or bolsters, which protect the delicate pneumadenia covered by them, and prevent its sudden compression, when the stem is rapidly contracted (**47**, p. 404; **48**, p. 529). My own observations on the structure and development of these interesting villi, made in Lanzerote (1867), and continued in Ceylon (1881), are in complete accordance with those of Chun. The hypocystic villi are always arranged in eight radial bunches which arise from the outside of the air-funnel; each villus, or each finger-like branch of the dichotomously-branched villi, consists of a single giant-cell, or a few (two to four, rarely more) giant-cells, which reach a diameter of one to two millimetres, and belong, therefore, to the largest cells of animal tissues; the nucleus of these vesicular and vacuolated exoderm-cells is ovate or cup-shaped, and has a diameter of 0·1 to 0·2 mm. The surface of the villi is covered with a vibratile epithelium, composed of small entoderm-cells with long cilia (Pl. XXIV. fig. 6). In the youngest Rhizophysidæ there are only eight single club-shaped giant-cells, which arise from the pylorus infundibuli; they correspond to the base of the eight radial apophyses of the air-funnel, which pass into the radial septa dividing the cavity of the pneumatophore into eight radial pouches in many Physonectæ (*e.g.*, Discolabidæ, compare above, p. 187). Afterwards arises a second corona of eight radial giant-cells from the distal base of the hypocystic funnel, and a third corona between the former and the latter (**48**, p. 530). By dichotomous ramification of these twenty-four giant-cells and further development of lateral branches arises the large elastic cushion, composed of numerous finger-like villi, which envelops in the adult Rhizophysidæ the greater part of the pericystic cavity and hangs down into the apical part of the stem-canal (Pl. XXIII. figs. 3, 4; Pl. XXIV. figs. 4, 5).

Siphons.—The feeding polypites are in the Rhizophysidæ usually of considerable size, sometimes very large, 4 to 8 centimetres long, or more, in the expanded state. The four segments of the siphon which are usually distinct in the majority of Siphonophoræ are rarely evident in this family; in the majority they are not distinct or not recognisable at all, so that the whole siphon is a simple cylindrical or spindle-shaped tube (Pl. XXIII. fig. 5; Pl. XXIV. figs. 1–4). Sometimes, however, especially in the peculiar *Linophysa*, the four segments are distinctly marked:—(1) A small pedicle to which the tentacle is attached; (2) a large ovate basigaster, the exoderm of which is full of cnidocysts; (3) a wide stomach with coloured hepatic glands; and (4) a very contractile tubular proboscis, with the tubular mouth-opening (**40**, p. 9, Taf. i. fig. 4). The thick wall of

the tubular siphon is always very extensible and contractile, provided with strong longitudinal and circular muscles. The entoderm of the stomach usually bears very numerous and small hepatic villi, containing pigment-granules and clear glandular vacuoles; rarely the hepatic glands are arranged into eight or sixteen longitudinal series, and form coloured "liver-ridges," as in *Linophysa*. The distal mouth is always very dilatable, and may be expanded in the form of a large circular suctorial disc (Pl. XXIII. fig. 5; Pl. XXIV. fig. 1).

Tentacles.—The long tubular tentacle which arises from the base of each siphon, on its superior or dorsal side, is rarely a simple, unbranched filament, similar to that of *Apolemia*, as in *Linophysa* (**40**, Taf. i. fig. 1). In all other known genera it is beset with a series of numerous equidistant tentilla or unilateral branches. These tentilla exhibit in the various genera of Rhizophysidæ similar differences in form and structure to those seen in the Agalmidæ among the Physonectæ, although a true cnidosac (as in the latter) is not developed. The tentilla are simple tubular filaments, with a unilateral series of cnidocysts, in *Aurophysa* and *Nectophysa* (Pl. XXIII. figs. 1–6); usually the axial or ventral side of the tentillum is beset with several rows of sensitive palpoblasts (fig. 6, *tw*), the abaxial or dorsal side with some series of spherical cnidoblasts (fig. 6, *kc*). The genera *Cannophysa* and *Pneumophysa* are distinguished by trifid tentilla (Pl. XXIV. figs. 8, 9); their distal end bears an odd terminal vesicle (fig. 9, *ta*) and two paired lateral horns (fig. 9, *tc*); these are armed in different ways with cnidonodes or roundish groups of spherical cnidocysts. *Rhizophysa*, finally, is distinguished by the compound structure of the tentacles which bear two, three, or more different kinds of tentilla; these are partly simple, partly trifid or branched; and usually there are scattered between them a small number of very large and remarkable appendages, first described in the Mediterranean *Rhizophysa filiformis* by Gegenbaur (**7**, Taf. xviii. figs. 7–9). They are flat, palmate, or hand-shaped leaves, dichotomously branched at the free distal margin, each branch provided with a spherical cnidocyst. In the similar Atlantic *Rhizophysa planostoma* (Péron), I observed in December 1866 similar but larger appendages, which bore in the middle of their upper or outer side a large purple ocellus; a pigment-ring with a strongly refracting globule in the centre. I suppose that this globule is a lens, and the ocellus a true eye.

Gonostyles.—Each cormidium of the Rhizophysidæ bears usually a single, clustered and monoclinic gonodendron only; this is attached to the node of the stem, immediately beyond the basal insertion of the siphon, in the ordinate cormidia of the Cannophysidæ (Pl. XXIV.); whilst it is attached to the internodes of the stem, between the siphons, in the loose cormidia of the Linophysidæ, where usually the siphons and gonodendra alternate regularly, in equal numbers (Pl. XXIII. figs. 1–3); but sometimes the number of gonodendra is augmented (in *Rhizophysa*), so that a variable number of gonostyles (two to four or more) arises from the internode between every two siphons; in some species

they are irregularly scattered. The gonostyle, or the axial stem of each gonodendron, is more or less branched, in the larger species with very numerous branches; each branch is monostylic and exhibits the same structure (Pl. XXIII. fig. 8), as is common to all Cystonectæ (compare above, p. 313). The distal end of the branch bears a spindle-shaped palpon with numerous cnidocysts (fig. 8, *gq*), and at its base a single large medusiform gynophore (*f*) surrounded by a corona of club-shaped androphores (*h*).

Synopsis of the Genera of Rhizophysidæ.

I. Subfamily CANNOPHYSIDÆ. Cormidia ordinate, separated by free internodes. Gonostyles attached to the stem immediately on the base of the siphons.		Tentilla simple, not branched,	66. *Aurophysa.*
		Tentilla trifid, with three terminal branches,	67. *Cannophysa.*
II. Subfamily LINOPHYSIDÆ. Cormidia loose. Gonostyles attached to the internodes of the stem, scattered between the siphons.	Tentacles simple, without tentilla; or with simple, unbranched tentilla.	Tentilla wanting, tentacles simple,	68. *Linophysa.*
		Tentilla simple, unbranched,	69. *Nectophysa.*
	Tentacles always with a series of tentilla, all or some of which are branched.	Tentilla all trifid, with three terminal branches,	70. *Pneumophysa.*
		Tentilla polymorphous, partly simple, partly branched or palmate,	71. *Rhizophysa.*

Genus 66. *Aurophysa*,[1] Haeckel, 1888.

Aurophysa, Hkl., System der Siphonophoren, p. 44.

Definition.—Rhizophysidæ with ordinate cormidia and free internodes of the stem, the gonostyles being attached on the base of the siphons. Tentilla simple, unbranched.

The genus *Aurophysa* comprises those Rhizophysidæ which may be regarded as the oldest and simplest forms of that family. The long tubular stem is divided into numerous equidistant nodes; attached to each node is an ordinate cormidium, composed of a siphon with its tentacle and a monostylic gonodendron. The long internodes between the cormidia are naked, as in *Apolemia* and the polygastric Calyconectæ. *Aurophysa* agrees in this important character with the following *Cannophysa* (Pl. XXIV.); both genera together represent the subfamily Cannophysidæ. *Aurophysa* differs, however, from *Cannophysa* in the form of the tentilla, which in the former are simple cylindrical filaments (as in *Nectophysa*, Pl. XXIII.), in the latter trifid, with three terminal branches. I observed an interesting species of this genus, *Aurophysa ordinata*, in December 1881, in the Indian Ocean, on the coast of Ceylon (off Colombo);

[1] *Aurophysa* = Air-bladder, ἀυρα, φῦσα.

the apical stigma of the pyriform pneumatophore was surrounded by a brown pigment-star with eight rays; the siphons were orange coloured, and the clustered gonophores, attached near to their base, yellowish, the long tentacles similar to those of *Nectophysa* (Pl. XXIII. figs. 5, 6). Very similar is *Rhizophysa inermis*, Studer (**40**, p. 13, Taf. i. figs. 3, 8, 9, 10), taken in the eastern part of the Indian Ocean, south of Sumatra (lat. 11° 18′ S., long. 120° 8′ E.). Studer tells us that this deep-sea form has no tentacles, but he describes and figures tentacles with a series of simple tentilla (fig. 10), apparently attached one to the base of each gonophore. I have no doubt that this was the usual tentacle, arising from the base of the siphon, strongly contracted and twisted around the base of the neighbouring gonophore.

Genus 67. *Cannophysa*,[1] Haeckel, 1888.

Cannophysa, Hkl., System der Siphonophoren, p. 44.

Definition.—Rhizophysidæ with ordinate cormidia and free internodes of the stem, the gonostyles being attached at the base of the siphons. Tentilla trifid, with three terminal branches.

The genus *Cannophysa* has the same ordinate cormidia as the preceding closely allied *Aurophysa*. It differs in the structure of the tentacles and the form of the tentilla, which are not simple lateral branches of the former, but each provided with three terminal appendages at the distal end. *Cannophysa*, therefore, bears the same relation to *Aurophysa* as in the following subfamily (Linophysidæ) *Pneumophysa* has to *Nectophysa*. A beautiful species of this genus was observed by me in January 1867 in the Canary Island Lanzerote; it is described in the following pages (Pl. XXIV.) as *Cannophysa murrayana*, and dedicated to my honoured friend Dr. John Murray. A similar species, differing in the special form of the pneumatophore and the tentilla, was found in the Tortugas, near Florida, and described in 1882 by Fewkes as *Rhizophysa gracilis* (**44**, p. 269, pl. vi. figs. 1–6).

Cannophysa murrayana, n. sp. (Pl. XXIV.).

Habitat.—North Atlantic, Canary Islands, Lanzerote, January 7, 1867 (Haeckel).

Corm.—Two living specimens, both very movable and integral, were captured by me in a current off Puerto Arrecife; the smaller was a young specimen without gonophores, and is figured in the expanded state, swimming with snake-like motion, in fig. 3 (twice natural size); the larger was a fully developed specimen with ripe gonophores, and is figured in the contracted state with spirally coiled up stem in fig. 1 (in profile), and fig. 2 (from above), slightly enlarged. The fully expanded corm attained a length of

[1] *Cannophysa*=Tube-bladder, *κάννα*, *φῦσα*.

300 to 400 mm. or more, but when contracted measured only 20 to 30 mm. The long and slender stem is a cylindrical tube scarcely 1 mm. in diameter when contracted, 2 or 3 mm. when expanded. It bears a series of ten to twelve fully developed cormidia in the larger specimen, besides numerous buds of young ones on the top of the stem, below the float. The ordinate cormidia are separated by naked internodes of equal length, the colour of the stem and the gonodendra is bright yellow, of the siphons and tentacles rose.

Pneumatophore (figs. 1–3, *p*, fig. 4, in profile; fig. 5 from above).—The large ovate or pyriform float has when contracted a length of 6 mm. and a breadth of 3 mm.; in the expanded state more than double this. Its thick-walled pneumatocodon (or outer wall) is separated by a wide cavity from the pneumatosac (or inner wall); this cavity (the pericystic chamber) is closed above and opens below into the axial canal of the trunk; its greater part is filled up by clustered groups of finger-shaped villi, which arise from the hypocystic funnel (fig. 4, *pv*). The large exodermal giant-cells which compose these villi reach the enormous size of 1·5 to 2 mm.; the surface of the villi is covered with a simple layer of ciliated entoderm cells (fig. 6). The thin chitinous wall of the cuticular pneumatocyst is covered outside by the simple exoderm-layer of the pericystic pneumatosac, inside by the thick yellowish-green endocystic tapetum (fig. 4, *pf*); this is composed of several strata of polyhedral exoderm-cells, filled with greenish granules (fig. 7). The endocystic tapetum is wanting only in the uppermost third or fourth of the pneumatocyst, which is covered outside by a hemispherical or cap-shaped mitra ocellaris (figs. 4, 5, *pp*). Above this mitra, which is composed of red polygonal pigment-cells, are visible the radial muscles (*pm*) and the circular muscles of the sphincter (*pn*), which closes the stigma, or the apical opening of the pneumatocyst (fig. 5, *po*). (For the special structure of the pneumatophore, compare above, p. 308.)

Siphons (figs. 1–4, *s*).—The feeding polypites are large cylindrical tubes of rose-colour, which open outside by the distal mouth, inside by the small proximal pedicle into the trunk. The thick muscular wall is very extensible and contractile, as is also the mouth, which may be expanded in the form of a circular suctorial disc. Distinct segments are not visible on the siphon; the greater part of its inside is covered with small and very numerous hepatic villi.

Tentacles (fig. 8).—The large cylindrical and rose-coloured tentacle, which is attached to the base of each siphon on its dorsal side, bears a series of very numerous tentilla; their size increases gradually towards the distal third of the tentacle; this third is a simple, thick, cylindrical tube, spirally coiled up, more deeply coloured, and covered with small papillæ, but without tentilla. The lateral branches are small and simple in the proximal part of the tentacle, trifid in the middle part. Each fully developed tentillum bears at the distal end an odd thick median club (fig. 9, *ta*) with a short terminal filament (*tf*); and on both sides of it a pair of slender cylindrical lateral horns (*tc*). Each of these three terminal appendages contains two rose-coloured cnidonodes, composed of

spherical cnidocysts, a proximal and a distal. The cnidocysts, which are contained in the middle ampullaceous dilatation of the odd median club (*ta*), are twice as large as those in the five other cnidonodes. The three terminal branches of the tentillum are solid, rather rigid cylinders, composed of a single column of large hyaline entoderm-cells, with a thin exodermal envelope similar to those of many hydropolyps and of the Narcomedusæ. The canal of the tentillum ends at the base, from which the three branches arise; its surface is covered with papillæ (fig. 9, *ts*).

Gonodendra (figs. 1, 2, *g*).—The single large gonodendron, which is attached to each node of the stem, immediately beyond the insertion of each siphon, has a bright golden-yellow colour. It is like a group of clusters and is composed of numerous smaller gonodendra (of the second and third order), the gonostyle being richly ramified. Each smallest group (or secondary gonodendron) is composed, as usual, of a single medusiform gynophore and a corona of club-shaped androphores, with a distal (rose-coloured) palpon. (Compare Pl. XXIII. fig. 8, and pp. 313, 328.)

Genus 68. *Linophysa*,[1] Haeckel, 1888.

Linophysa, Hkl., System der Siphonophoren, p. 45.

Definition.—Rhizophysidæ with loose cormidia, the gonostyles being attached to the internodes of the stem, between the siphons. Tentacles simple, without tentilla or lateral branches.

The genus *Linophysa* is represented by a single species only, inhabiting the depths of the Atlantic between 800 and 1600 fathoms, and captured several times by Studer, who described it under the name *Rhizophysa conifera* (40, p. 4, Taf. i. figs. 1, 2, 4, 7, 13–18). It differs from all other Rhizophysidæ in the simple form of the long tubular tentacles, which bear no tentilla or lateral branches. The siphons possess sixteen black liver-ridges (while the other Rhizophysidæ possess hepatic villi). The strobiliform gonostyles seem to alternate with the siphons, the cormidia being loose. Each gonostyle bears, like a fir-cone, a spiral row of imbricated gonodendra, each covered by a scale (gonopalpon ?). These and other structures described by Studer are so peculiar that *Linophysa conifera* may be perhaps the type of a separate family—Linophysidæ.

Genus 69. *Nectophysa*,[2] Haeckel, 1888.

Nectophysa, Hkl., System der Siphonophoren, p. 45.

Definition.—Rhizophysidæ with loose cormidia, the gonostyles being attached to the internodes of the stem, between the siphons. Tentacles branched; tentilla simple, not branched.

[1] *Linophysa* = Filament-bladder, *λίνον*, *φῦσα*.

[2] *Nectophysa* = Swimming-bladder, *νήκτης*, *φῦσα*.

The genus *Nectophysa* resembles *Aurophysa* in the structure of the tentacles, and has the same simple tentilla in the form of slender cylindrical filaments. It differs, however, in the composition of the cormidia, which are not ordinate, but loose; the gonostyles are not attached to the base of the siphons, but alternate with them and are scattered along the stem. A beautiful species of this genus was observed by me, in December 1866, in the Canary Island Lanzerote, and is described in the following lines (Pl. XXIII.) as *Nectophysa wyvillei*, dedicated to the memory of Sir Wyville Thomson. Another closely allied species seems to be *Rhizophysa eysenhardtii*, described by Gegenbaur (10, p. 78, Taf. xxxi. figs. 46–49).

Nectophysa wyvillei, n. sp. (Pl. XXIII.).

Habitat.—North Atlantic; Canary Islands, Lanzerote, December 26, 1866 (Haeckel).

Corm.—The long cylindrical stem has a rose-coloured exoderm, a yellowish entoderm, and in the fully expanded state (figs. 1, 2) a length of 300 mm. or more and a thickness of about half a millimetre; in the contracted state, and spirally coiled upon itself (with a dexiotropic spiral, fig. 3), it is much thicker (2 or 3 mm.); but its length is only 10 to 20 mm. The circular as well as the longitudinal muscles are strongly developed. The specimen figured in fig. 2 bore about a dozen fully developed siphons, besides some younger ones on the apex; and regularly alternating with them, midway between each two siphons, a large gonodendron. The general colour of both is rose.

Pneumatophore (figs. 1–4, *p*).—The float exhibits the same structure as is described above of *Cannophysa murrayana* (compare pp. 308 and 325, and Pl. XXIV. figs. 1–7). In the fully expanded state it was pyriform or ellipsoidal, in the contracted state subspherical. As the corm was irritated, and the stem much contracted (fig. 3), the pneumatocyst was constricted in its equator, and a large air-bubble (fig. 3, *x*) escaped from the opened apical stigma (*po*); the animal sank down to the bottom of the glass vessel, and some time afterwards was again expanded, the siphons being partly attached by a suctorial mouth-disc to the bottom (fig. 2). The apical half of the pneumatosac is covered by a violet mitra ocellaris (fig. 3, *pp*), whilst the distal half of the large pericystic cavity was filled with numerous hypocystic villi (*pv*) arising from the air-funnel. In the highest state of contraction of the stem, after the total expulsion of air from the pneumatocyst, the clustered villi were all pressed downwards into the dilated apical portion of the stem (fig. 4, *pv*). (Compare p. 310.)

Siphons (figs. 1–4, *s*, 5).—The feeding polypites are in the contracted state short rose-coloured spindles, in the expanded state cylindrical tubes 15 to 20 mm. in length, 1 to 2 mm. in breadth. Their thick muscular wall is very expansible and contractile, the inside covered with numerous small hepatic villi. No different segments

can be distinguished. The distal mouth is often expanded in the form of a large circular suctorial disc.

Tentacles (figs. 1, 2, 5, *t*).—The long and very expansible tentacle which arises from the base of each siphon (on its upper or dorsal side) is a cylindrical tube of rose-colour, purple at the distal end, beset with a series of very numerous simple lateral branches; their length increases gradually from the proximal to the distal end. These tentilla are thin cylindrical filaments with a simple rounded distal apex. Their canal is excentric, since the thickened dorsal wall is filled with spherical cnidocysts (figs, 6, *kc*, 7), whilst from the thinner ventral wall arise numerous conical papillæ, each of which bears a palpocil or a feeling bristle (fig. 6, *tw*).

Gonodendra.—The single gonodendron, which hangs down like a pediculate cluster of grapes from each internode, midway between each two siphons, is rose-coloured and composed of numerous secondary and tertiary gonodendra. Each of the latter (fig. 8) is composed of a single large medusiform gynophore (*f*) and a corona of five to ten (usually seven or eight) ovate androphores (*h*) around its base; the distal end is occupied by a large, very movable, spindle-shaped palpon (*gq*). Each branch of the gonostyle bears two or three pairs of opposite secondary branches.

Genus 70. *Pneumophysa*,[1] Haeckel, 1888.

Pneumophysa, Hkl., System der Siphonophoren, p. 45.

Definition.—Rhizophysidæ with loose cormidia, the gonostyles being attached to the internodes of the stem, between the siphons. Tentacles branched; tentilla trifid, with three terminal branches.

The genus *Pneumophysa* differs from the preceding *Nectophysa* in the form of the tentilla, which are not simple tubular filaments, but provided with three terminal appendages similar to those of *Cannophysa* (Pl. XXIV. figs. 8, 9). The odd median appendage is larger and ampullaceous, whilst the two paired lateral horns are smaller and slender. The cormidia are not ordinate, as in *Cannophysa*, but loose, so that a single gonodendron is attached to each internode of the stem midway between two siphons (almost as in *Nectophysa*, Pl. XXIII. figs. 1–3). The single known species of this genus, *Pneumophysa gegenbauri*, was observed by me in December 1881 in the Indian Ocean, and will be described on another occasion. A second species, similar to this, was noticed in my System der Siphonophoren (**95**, p. 45) as *Pneumophysa mertensii* (=*Epibulia mertensii*, Brandt, **25**, p. 33). But a closer examination of the excellent figures which its discoverer, Mertens, has left of this species, taken in the Tropical Pacific, has convinced me that it belongs to the following genus, *Rhizophysa*.

[1] *Pneumophysa* = Air-bladder, πνεῦμα, φῦσα.

Genus 71. *Rhizophysa*,[1] Péron et Lesueur, 1807.

Rhizophysa, Péron et Lesueur, **14**, Voyage aux terres australes.

Definition.—Rhizophysidæ with loose cormidia, the gonostyles being attached to the internodes of the stem, between the siphons. Tentacles branched; tentilla polymorphous, partly simple, partly branched.

The genus *Rhizophysa* is the oldest known form of Rhizophysidæ, its Mediterranean type having been described as early as 1775, by Forskål, under the name *Physophora filiformis* (**11**, p. 120, Tab. xxxiii. fig. F). Péron afterwards, in 1807, figured a similar form, observed in the Atlantic, under the name *Rhizophysa planostoma* (**14**, pl. xxix. fig. 3). Although this latter figure is very incomplete, it may be that it is identical with a similar *Rhizophysa*, a single specimen of which I captured in December 1866, in the Canary Island Lanzerote. The structure of this Atlantic species, for which I retain Péron's name, was very similar to that of the well-known Mediterranean form, the best description of which was published in 1854 by Gegenbaur (**7**, p. 324, Taf. xviii. figs. 5–11). The Atlantic *Rhizophysa planostoma* differed, however, in the peculiar coloration (the pneumatophore, the stem, and the tentacles being rose-coloured, the siphons violet), and in the special form of the tentilla; the majority of these were trifid, with an odd median club and two paired lateral horns (similar to those of *Cannophysa murrayana*), but scattered between them was a number of very large palmate tentilla, differing from those figured by Gegenbaur (*loc. cit.*, fig. 8) mainly by a large purple ocellus on the convex outside; the peculiar calcarate tentilla, which Gegenbaur compared with a bird's head in the Mediterranean *Rhizophysa filiformis* (*loc. cit.*, fig. 9), were absent. Compare also Fewkes (**41**, pl. ii.). A third species of the true *Rhizophysa*, different from the two former, is described by Brandt as *Epibulia mertensii* (**25**, p. 33). The excellent figure of it, drawn from nature by Mertens (but unfortunately not published), exhibits distinctly two different kinds of branched tentilla; the colour of the corm is yellowish-brown, the siphons rose. It was observed in the Northern Pacific in 1827.

Family XXII. Salacidæ, Haeckel, 1888.

Salacidæ, Hkl., System der Siphonophoren, p. 45.

Definition.—Cystonectæ polygastricæ with a long tubular trunk of the siphosome, bearing in its ventral median line numerous polygastric cormidia, separated by free internodes. Each clustered cormidium composed of several siphons and several tentacles. Pneumatosaccus large, without radial septa and pericystic radial pouches, but with eight or more radial groups of hypocystic villi.

[1] *Rhizophysa* = Root-bladder, ῥίζα, φῦσα.

The family Salacidæ is an interesting group intermediate between two very dissimilar families of Cystonectæ, the macrostelious Rhizophysidæ (XXI.) and the brachystelious Physalidæ (XXIV.). It agrees with the former in the long tubular stem and the long naked internodes between the ordinate cormidia, and further in the peculiar structure of the pneumatophore, possessing hypocystic villi; on the other hand, it agrees with the Physalidæ (Pl. XXVI.) in the polygastric structure of the cormidia and the large size of the float, and with *Physalia* especially in the structure of the siphons and the simple tentacles, bearing a series of reniform cnidonodes.

The remarkable species which represents this connecting family is figured in Pl. XXV. as *Salacia polygastrica;* it was taken by the Challenger in the Tropical Atlantic (Station 338), from a depth of 1990 fathoms. The single specimen examined was so well preserved that it was possible by staining and dissecting it to recognise the essential structure of all the different organs. The morphological relation which the polygastric cormidia of Salacidæ bear to the closely allied monogastric cormidia of Rhizophysidæ is very similar to that which, among the Physonectæ, the Apolemidæ bear to the Agalmidæ. An *Apolemia* which has lost its nectophores and bracts would be very similar to a *Salacia*. The peculiar structure of the gonodendra, however, in this latter, and the structure of the large float, with eight radial bunches of hypocystic villi, leaves no doubt that they are most closely allied to the Rhizophysidæ.

Genus 72. *Salacia*,[1] Haeckel, 1888.

Salacia, Hkl., System der Siphonophoren, p. 45.

Definition.—Salacidæ with ordinate cormidia, each of which is composed of several siphons and monostylic gonodendra. The single tentacle, which arises from the base of each siphon, is a long simple tube, beset with a series of reniform cnidocysts.

The genus *Salacia* was established by Linné in 1746 for that very large Cystonect which was called *Physalia* by Lamarck in 1816 (compare **1**, p. 158; **79**, p. 24). Since the latter name is generally accepted, and the former (although seventy years older) entirely forgotten, I employ it for this new genus, instead of giving a new name. The characters of the genus *Salacia*, as the only known type of Salacidæ, are the same as described above for that family. As a peculiar character of the genus may be pointed out the shape of the tentacles, which agree with those of *Physalia*. The species described in the sequel (Pl. XXV.) was discovered by the Challenger in the depths of the Tropical Atlantic (Station 338). Another species of the same genus seems to be the (incompletely known) North Atlantic form, which Fewkes described in 1886 as *Rhizophysa uvaria* (**45**, part xii. p. 967, pl. x. fig. 6).

[1] *Salacia*, name of a sea-goddess, wife of Okeanos.

Salacia polygastrica, n. sp. (Pl. XXV.).

Habitat.—Tropical Atlantic; Station 338, March 21, 1876; lat. 21° 15′ S., long. 14° 2′ W.; depth, 1990 fathoms.

Corm.—The trunk of the single specimen observed had in the expanded state a length of 120 to 150 mm., and bore about eight developed cormidia, besides the same number of young and undeveloped ones in the proximal portion, beyond the apical float. The ordinate cormidia were separated by long naked internodes. The cylindrical trunk was filiform and had a diameter of only half a millimetre, but exhibited a high degree of firmness and elasticity. Although it was much contracted in the spirit bottle, it was possible, by softening it gradually with water, to make it so elastic that it could be extended to that degree which is figured in Pl. XXV. fig. 1.

Pneumatophore (fig. 1, lateral view; fig. 2, horizontal section, near the pylorus infundibuli; fig. 3, apical view, fore-shortened).—The large float is ellipsoidal, 10 mm. long, 6 mm. broad. Its apex is truncate, with a central dimple, which contains the stigma or the apical opening for the emission of gas (fig. 3, *po*). In the apical view (fig. 3) strong radial muscles (*pm*) are visible, which open the stigma; beyond them lie the circular muscles which compose the sphincter closing it. This eye-like sphincter is surrounded by a corona of eight roundish radial lobes, covered by dark pigment-granules. I could not make out the true nature of these lobes (fig 3, seen from above, and fig. 1, in profile). The uppermost part of the pericystic cavity appeared to be divided by eight radial septa into eight radial pouches opening below; but the dark pigment covering them (much richer than is represented in fig. 3) prevented their distinct recognition. The apparent septa may be only radial folds.

Pneumatocyst.—The chitinous air-flask is spindle-shaped and occupies the upper two-thirds of the float-cavity; it exhibits two openings on the two poles of its axis, the apical stigma for the emission of gas (fig. 3, *po*), and the basal pylorus infundibuli (fig. 2, *py*), through which the gas, secreted by the exodermal epithelium of the infundibulum, enters into the cavity of the air-flask. The outside of the cuticular pneumatocyst is covered by its matrix, the exodermal pneumatosac; this has an annular constriction round the pylorus (fig. 2, *py*), and forms beyond it a hemispherical cavity, the infundibulum or pneumatochone. From this arise eight radial bunches of hypocystic villi (figs. 1–3, *pv*), which fill up the greater part of the hypocystic cavity. Each villus is composed of a few colossal exodermal giant-cells (1 to 2 mm. in diameter) and of a ciliated epithelium of small entoderm cells covering them (as in Pl. XXIV. fig. 6).

Cormidia.—Each ordinate polygastric cormidium (fig. 4) is a botryoidal cluster composed of about ten to twenty siphons and gonodendra, each siphon provided with a long simple tentacle. Four to six siphons only seem to be fully developed in each

cormidium and possess a distinct mouth-opening and a tentacle; these are not recognisable in a greater number of smaller and thinner spindle-shaped tubes, which arise between the former; they may be either young and undeveloped siphons, or perhaps palpons which remain permanently mouthless. The difference between siphons and palpons in *Salacia* does not seem to be sharp, as in *Physalia*. All the components of each cormidium arise from the node of the trunk so densely crowded that it is impossible to determine whether there is any close relation between the clustered gonodendra and the siphons.

Siphons (figs. 4, 5, *s*).—The fully developed polypites are slenderly spindle-shaped, attain in the expanded state a length of 8 to 12 mm., a breadth of about 1 mm., and are very similar to those of *Physalia* and *Alophota* (Pl. XXVI.). The four usual segments are sometimes recognisable in the strongly contracted siphon (fig. 5). The short pedicle bears a subspherical basigaster with thickened exoderm (*sb*); from its base arises the tentacle (*t*). The wide stomach (*sm*) is covered inside with numerous pigmented hepatic villi (*sv*). The contractile proboscis (*sr*) opens at the distal end by a mouth which is often expanded in the form of a roundish or circular suctorial disc; its margin is armed with a ring of cnidocysts (fig. 4, *so*).

Tentacles (*t*).—The single long tentacle which arises from the base of each fully developed siphon is very similar to those of *Physalia*, a simple cylindrical tube with an excentric canal. The dorsal side of the tube bears a series of very numerous reniform cnidonodes, whilst the ventral side is naked (compare Pl. XXV. figs. 4, 5, *t*, and Pl. XXVI. figs. 1–6, *t*).

Gonodendra (figs. 4, *g*, 7).—The clustered gonodendra, which arise from each node between the siphons, have a richly branched gonostyle. Each ultimate branch (Pl. XXV. fig. 7) exhibits essentially the same structure as in *Physalia*, and is composed (Pl. XXVI. fig. 8) of a single large gynophore (*f*, a medusiform umbrella with four radial canals, the manubrium of which develops after the detachment), a clustered group of smaller club-shaped androphores (*h*), and a number of gonopalpons (*gq*).

Family XXIII. Epibulidæ, Haeckel, 1888.

Definition.—Cystonectæ polygastricæ with a short inflated trunk of the vesicular siphosome, which is spirally convoluted beyond the basal side of the large subvertical pneumatophore. Cormidia ordinate in a spiral ring, protected by a corona of palpons. Pneumatosaccus without radial septa and pericystic radial pouches, but with eight or more radial groups of hypocystic villi.

The family Epibulidæ represents a new interesting group of Cystonectæ, which was very imperfectly known up to this time. Two species only of *Epibulia*, both captured

in the North Pacific, have been incompletely described—*Epibulia chamissonis* by Eysenhardt (**77**, Tab. xxxv. fig. 3), and *Epibulia erythrophysa* by Brandt (**25**, p. 34). Unfortunately the excellent figure of the latter species, which Mertens in 1817 had drawn from life, has never been published. It is much to be lamented that this, as well as all the other wonderful drawings of Siphonophoræ, which Mertens had executed with the most admirable accuracy, have never found their way into literature. Comparing Mertens' figure of *Epibulia erythrophysa* with a similar splendid Cystonect which I myself observed in Ceylon (1882), I have no doubt that both species belong to one and the same genus. The accurate examination of this Indian *Epibulia ritteriana* (Pl. XXII. figs. 6–8), and their comparison with the closely allied Physalidæ, has led me to the opinion that this genus represents a new family, intermediate between the latter and the Rhizophysidæ. Another genus of this family may be perhaps *Angela cytherea* of Lesson, which, however, is too imperfectly examined (**3**, p. 496, pl. ix. fig. 1).

The Epibulidæ agree with the next allied Physalidæ in the bag-shaped form of the short and wide trunk of the siphosome. But the large pneumatophore does not extend along the dorsal side into the cavity of the vesicular trunk; it occupies rather the apical half of the corm, whilst the siphosome occupies its basal half. The Epibulidæ agree in this respect with the other Cystonectæ, and differ essentially from the true Physalidæ, with which I had united them (in 1887) in my System (**95**, p. 46, Genus 73). A further consequence of this important difference is that the main axis of the large pneumatophore stands subvertically or obliquely inclined in the Epibulidæ (as in the other Cystonectæ), whilst it is subhorizontal in the Physalidæ; the stigma, therefore (or the apical air-pore), occupies in the former the superior pole, in the latter the anterior pole of the floating corm. A further difference is, that the ventral line of the shortened trunk, from which the budding cormidia arise, is circular or rather spiral in the Epibulidæ, straight in the Physalidæ, and that a complete corona of palpons surrounds the base of the float in the former, but is wanting in the latter.

The whole form of the corm, as well as the structure of its single parts, is in the Epibulidæ very like that in the Cystalidæ (Pl. XXII. figs. 1–5); but the important difference between them is that the former are polygastric, the latter monogastric. It is very probable, however, that the Epibulidæ have arisen directly from the Cystalidæ (by secondary multiplication of the siphons and tentacles), as well from a phylogenetical as from an ontogenetical point of view (compare above, p. 315).

Nectosome (Pl. XXII. fig. 6, *p*; fig. 7, longitudinal section; fig. 8, transverse section).—The pneumatophore has in the Epibulidæ the same structure as in the Salacidæ and Rhizophysidæ; it includes eight radial bunches of hypocystic villi. Its apex bears the stigma typical of all Cystonectæ. The living *Epibulia*, when it wishes to sink down, expels at will the gas through this apical pore; as I have observed in Ceylon. The apical part of the pneumatosac is intensely coloured by a pigment-cap (mitra ocellaris, *pp*).

Siphosome.—The composition of the siphosome, and especially the arrangement of the crowded cormidia along the median ventral line of the vesicular and spirally convoluted trunk, is in the Epibulidæ very similar to that in the Discolabidæ. If the nectophores of *Physophora* or of *Discolabe* were detached and the stem contracted, and if the apical float were inflated, the external appearance would be nearly the same as in *Epibulia*. The corona of large projecting palpons which surrounds the base of the nectosome and covers the siphosome is also very similar. It may even be that the composition of the ordinate cormidia, and their arrangement around the segmented shortened trunk, is very similar in both groups. But a closer examination informs us that this similarity is a mere analogy, not a true homology; the typical structure of the single persons and organs (mainly of the pneumatosac and the gonodendra) is in the Epibulidæ very different from that in the Discolabidæ, and agrees with that in the other Cystonectæ.

Synopsis of the Genera of Epibulidæ.

Tentilla simple, filiform, undivided, ... 73*a*. *Epibulia*.
Tentilla trifid at the distal end, with an odd median terminal ampulla and two paired lateral horns, ... 73*b*. *Angela*.

Genus 73*a*. *Epibulia*,[1] Eschscholtz, 1829.

Epibulia, Esch., System der Acalephen, p. 148.

Definition.—Epibulidæ with simple filiform tentilla, each representing an undivided lateral branch of the tentacle.

The genus *Epibulia* was founded by Eschscholtz (**1**, p. 148) for the reception of two very different Cystonectæ, viz., (1) the Mediterranean *Rhizophysa filiformis*, Lamarck (described by Forskål in 1775 as *Physophora*), and (2) *Rhizophysa chamissonis*, Eysenhardt, from the North Pacific (**77**, p. 40, Tab. xxxv. fig. 3). Since the name *Rhizophysa* is now generally accepted for the former, we retain the name *Epibulia* for the latter. Another species, closely allied to this, was afterwards described by Brandt as *Epibulia erythrophysa* (**25**, p. 34). The excellent figure of this Pacific species, which Mertens had painted from life, but which, alas, was never published, leaves no doubt that it belongs to this genus, and that it is closely allied to the new Indian species which I myself observed living in Ceylon, and which is described in the sequel as *Epibulia ritteriana*, dedicated to the highly esteemed protector of phylogenetic science, Dr. Paul von Ritter of Basel (Pl. XXII. figs. 6–8).

Considerable confusion in the nomenclature of this genus (as also of other genera

[1] *Epibulia* = Artful, ἐπιβουλία.

of Siphonophoræ) was introduced by Carl Vogt (**6**), who in 1854 gave the name *Epibulia aurantiaca* to a Calyconect, which had been named *Galeolaria* by Blainville seventeen years before (**24**, p. 139). Compare our Genus 26. Since also many succeeding authors had retained the name *Epibulia* in the sense of Vogt, I followed their example in my System, and had called the above mentioned species of Brandt, &c., *Arethusa* (**95**, p. 35). But considering now more accurately the rules of priority, I find it much more justifiable to employ the name *Epibulia* in the sense of the older authors, Eschscholtz and Brandt.

Epibulia ritteriana, n. sp. (Pl. XXII. figs. 6–8).

Arethusa brachysoma, Hkl., System der Siphonophoren, p. 46.

Habitat.—Indian Ocean, Ceylon, off Belligemma, January 1882 (Haeckel).

Corm.—The complete corm of this beautiful Cystonect, which I captured in the living state, off Belligemma, Ceylon, and which is figured in Pl. XXII. fig. 6, four times enlarged, had in this fully expanded state a diameter of 30 mm. to 40 mm., in the contracted state scarcely one-fourth of that size. All parts of the body were splendidly coloured, the large ovate pneumatophore light red, with a purple pigment-cap in the apical third; the corona of palpons rose, the siphons and the tentacles yellow, and the gonodendra purple. The vivid motions of this delicate Siphonophore, the variable play of the tasting palpons, the feeding siphons, and the capturing filaments, offered a most splendid aspect. The number of cormidia composing the corm was eight; four siphons and tentacles, and four large gonodendra were fully developed, two others (smaller) half developed, and two very small and young. The number of palpons, however, which composed the corona beyond the apical pneumatophore, was very large, forty to sixty or more, beside many young buds, so that six to ten palpons may belong to each cormidium. All these parts of the siphosome were so arranged around its vesicular axial trunk, that the palpons occupied the proximal, the siphons the distal part of the cormidium, and the gonodendra were attached between them (as in the Anthophysidæ and Discolabidæ); but usually the siphons were more or less protruded, so that the gonodendra appeared to occupy the central base of the corm. Unfortunately, I was not able to examine closely the form of the central trunk of the siphosome, and the mode of attachment to the cormidia; probably it is similar to that of the Anthophysidæ, Discolabidæ, and Nectalidæ; all that I could observe of the trunk was that it represented a shortly conical or ovate bladder, coiled up in a spiral, with a single dexiotropic turning.

Pneumatophore (Pl. XXII. fig. 6, *p*, in profile; fig. 7, in vertical section through the axis; fig. 8, transverse section).—The great float filled with air is ovate, and has a diameter of 10 to 12 mm. in the expanded state; in the contracted state, however,

after the emission of gas through the apical pore, it represented a depressed spheroid of 3 to 4 mm. only. The pneumatocodon, or the outer wall of the pneumatophore (fig. 7, *pu*), is separated from the inner wall, or the pneumatosaccus (fig. 7, *ps*), by a wide cavity (*pc*). This pericystic cavity opens below into the stem-cavity of the siphosome (*at*), whilst it is closed above, surrounding like a ring the apical pore (*po*) where both walls are connected. The distal or inferior half of the pericystic cavity is filled by the numerous finger-shaped hypocystic villi (*pv*), arising in eight radial bunches from the air-funnel (*pi*).

Pneumatocyst (figs. 6–8, *pf*).—The chitinous air-flask is an ovate bladder, suspended from the apex of the surrounding pneumatophore, and hanging down freely into its cavity. Its cuticular wall has two opposite openings on the poles of its axis. The superior or proximal opening is the apical stigma (*po*) serving for the emission of gas when the animal wishes to sink down; it may be closed by the sphincter stigmatis, a strong ring-muscle, the antagonist of which is a corona of radial muscles, opening the stigma. The inferior or distal opening of the air-flask is the pylorus infundibuli (*py*), by which its cavity communicates with the subjacent air-funnel (*pi*). The convex outside of the pneumatocyst is covered by the simple exodermal epithelium of the pneumatosac (*ps*), and in the upper third by the mitra ocellaris, a purple hemispherical cap composed of elegant polygonal pigment-cells (*pp*). The concave inside of the air-flask is naked in the upper third (covered by the ocellar mitra, *pp*); it is lined in the two lower thirds by the endocystic tapetum (*pd*), a stratified glandular epithelium composed of the same yellowish-green exoderm cells as line the cavity of the subjacent spheroidal air-funnel (infundibulum, *pi*). The greenish glandular epithelium is the important pneumadenia and secretes the gas.

Hypocystic Villi.—The air-funnel (infundibulum or pneumatochone, *pi*), which forms the blind distal portion of the air-sac, is surrounded by a regular corona of eight radial clusters, composed of numerous branched hypocystic villi. Each villus is composed of a few colossal giant-cells of the exoderm (arising from the outside of the pneumadenia) and covered by a vibratile epithelium of small ciliated entoderm-cells (Pl. XXIV. fig. 6). The diameter of the vesicular giant-cells is 1 to 2 mm., and their nuclei, when stained by carmine, are visible to the naked eye. The further structure and the physiological function of these parts are the same as in the Rhizophysidæ, (described above, pp. 310, 320).

Siphons (fig. 6, *s*).—The large feeding polypites are 10 to 15 mm. long, very movable spindle-shaped tubes with a thick muscular wall. The short basal pedicle bears the tentacle on its dorsal side. The largest part is the dilated stomach, covered inside with numerous yellow hepatic villi. The distal proboscis is very muscular; its mouth-opening may be expanded in the form of a circular suctorial disc, the margin of which is divided into sixteen lobes.

Tentacles.—The single tentacle which arises from the base of each siphon is a long cylindrical tube, in the fully expanded state 80 to 120 mm. long or more. It is beset with a series of very numerous tentilla or lateral branches. These are simple, cylindrical filaments, of the same shape as in *Nectophysa wyvillei* (Pl. XXIII. figs. 5, 6). The concave ventral side of the tentilla bears sensible papillæ, the convex dorsal side is armed with spherical cnidocysts.

Palpons.—The corona of tasters, which occupies the uppermost part of the siphosome, immediately beyond the float of the nectosome, is very similar to that of the Discolabidæ (*Physophora*). The palpons (*q*) are slender, very movable, cylindrical tubes with a thick muscular wall. Their cavity opens at the proximal end into the vesicular trunk, whilst the closed distal end is armed with cnidocysts and a purple ocellus. Their function is not only sensory, but also protective and capturing, as in the Discolabidæ.

Gonodendra.—Each cormidium is monoclinic and bears a very large gonodendron, attached by a short pedicle to the periphery of the vesicular trunk, between the superior palpons and the inferior siphon. The gonostyle is richly branched, and each ultimate branch, similar to that of the Salacidæ (Pl. XXV. figs. 6, 7), bears a large, distal, medusiform gynophore and a bunch of club-shaped androphores with small gonopalpons scattered between them.

Epibulia ritteriana, observed in the living state, with its vivacious movements, belongs to the most beautiful and elegant forms of Siphonophoræ; at the same time it is of a peculiar morphological and phylogenetic interest. I dedicate, therefore, this splendid Indian form to my honoured friend, Dr. Paul von Ritter of Basel, the magnanimous founder of the "Paul von Ritter'sche Stiftung für phylogenetische Zoologie an der Universität Jena."

Genus 73*b*. *Angela*,[1] Lesson, 1843.

Angela, Lesson, Acalèphes, p. 496.

Definition.—Epibulidæ with trifid tentilla, each lateral branch of the tentacles being divided at the distal end into a terminal ampulla and two lateral horns.

The genus *Angela* was established by Lesson (*loc. cit.*, p. 496, pl. ix. fig. 1) for a Siphonophore, a figure of which, drawn from life, had been given to him by Rang, without description. Comparing this figure with our *Epibulia* (Pl. XXII. fig. 6), I suppose that *Angela cytherea* (from the Tropical Atlantic?) may have been a true Epibulid. The base of the large, depressed, spheroidal pneumatophore is surrounded by a corona of numerous palpons, and inside of it depend eight very long tentacles, provided with a series of numerous tentilla. Each tentillum is divided into three

[1] *Angela*, a female angel.

terminal branches, an odd median ampulla and a pair of lateral horns (fig. 1, *a*). If this explanation be right, *Angela* would bear the same relation to *Epibulia* as *Cannophysa* does to *Aurophysa*.

Family XXIV. Physalidæ, Brandt, 1835.

Physalidæ, Brandt, Prodromus descriptionis, &c., **25**, p. 36.

Definition.—Cystonectæ polygastricæ with a short inflated trunk of the vesicular siphosome, which is horizontally expanded along the ventral side of the subhorizontal gigantic pneumatophore. Cormidia in a multiple series along the ventral side of the trunk, usually loose. Pneumatosaccus very large, sometimes with a chambered dorsal crest, without radial septa and hypocystic villi.

The family Physalidæ comprises the largest and most interesting Cystonectæ, which surpass all the other Siphonophoræ in the enormous size of the inflated pneumatophore and the vigorous tentacles, the splendid colours of the peculiar siphosome, and the dangerous poisons of the urticating organs. Since some forms of this interesting family, and especially the largest of all, the Atlantic *Caravella maxima*, occur in great swarms floating on the surface of the ocean, they have been well known to travellers and sailors for a long time. In many voyages they are mentioned under the popular names "Caravella, Galera, Fregatta, Ship of Guinea, Portuguese Man-of-War," &c. Nevertheless the natural history of the Physalidæ has hitherto been very imperfectly studied, and there remains much to be done towards a complete knowledge of them.

The genus *Physalia*, generally accepted as the only one of this family, was established in 1816 by Lamarck (**90**) for those *Caravellæ* which O. F. Müller and Gmelin in the preceding century had described as *Medusa caravella*, Linné, or *Holothuria physalis*. Neither the name *Salacia*, employed for them by Linné in a few editions of his Systema naturæ (1756, **1**, p. 158), nor the name *Arethusa*, proposed by Patrick Browne in 1789, have yet any application (compare above, p. 330, and below, p. 349). While Lamarck distinguished five different species, with very insufficient definitions, Eschscholtz accepted only three, the common Atlantic *Physalia caravella* (the largest of all, with numerous large tentacles), the smaller *Physalia pelagica* (from the Southern Atlantic and Indian Oceans), and the larger *Physalia utriculus* from the Pacific; the two latter species have only a single large tentacle, and differ mainly in the form of the pneumatophore. Recently Chun, in the latest paper on *Physalia* (**83**, p. 557), unites these two latter forms, accepting two species only of this genus—*Physalia caravella*, with many large main-tentacles, from the Atlantic, and *Physalia utriculus* (including *Physalia pelagica*) from the Indo-Pacific Ocean. All recent authors have accepted the genus *Physalia* as the only type of this family.

The family Physalidæ was established in 1835 by Brandt (**25**, p. 36). He first distinguished two different subgenera in the genus *Physalia*, viz., (1) *Salacia* (or *Physalia* proper), with a chambered dorsal crest of the float; and (2) *Alophota*, without crest. This distinction, although not accepted by later authors, is very important, since the crestless state of the pneumatophore, regarded from a phylogenetic point of view, must necessarily precede the crested state. There still exist also to-day small Physalidæ which reach sexual maturity in the crestless state. We establish for these the subfamily Alophotidæ, and oppose it to the crest-bearing subfamily Caravellidæ. Among the small Alophotidæ, as well as among the large Caravellidæ, occur two different forms which may be distinguished as genera; one of these (*Alophota* and *Physalia*) bears only a single large main tentacle, besides numerous small accessory tentacles; the other group (*Arethusa* and *Caravella*) bears numerous large main tentacles of nearly equal size (besides the small accessory tentacles).

The distinction of species in these four genera of Physalidæ is a very difficult task, since the entire family is transformistic, and all the so-called "good species" are connected by Darwinian intermediate forms. Nevertheless there exist a number of "geographical species" as local forms in the different seas. In the majority of the numerous descriptions the species of Physalidæ are founded upon slight differences in the variable coloration, or different states of contraction of the very variable pneumatophore and other parts (compare Huxley, **9**, p. 99, and Chun, **83**, p. 557). A better and more natural distinction of "relatively good species" will be got when the future observers carefully regard the following anatomical structures:—(1) the grouping and composition of the monogastric or polygastric cormidia; (2) the relation of the basal protosiphon (at the distal end of the float) to the secondary siphons (or metasiphons) on its ventral face; (3) the difference in structure and form of the pneumatophore, mainly at its apical and basal poles; (4) the structure of the crest, the number of its chambers, &c.

Cystonula-Larvæ.—The organisation of the large adult Physalidæ, with their complicated structure and composition of hundreds of polymorphous parts, is so difficult to conceive, and seems to be so widely different from that of other Siphonophoræ, that it has led most authors to many erroneous opinions. To arrive at its true understanding, it is indispensable to regard carefully and compare critically the smallest and simplest forms of this peculiar family, and especially the youngest larvæ with a very simple structure (*Cystonula*, Pl. XXVI. figs. 1, 2). The first larvæ of a very young stage were described in 1859 by Huxley (**9**, p. 102, pl. x. figs. 1, 2). I myself had in 1866, in Lanzerote, the opportunity of observing living a number of similar larvæ and of comparing them with the simplest and oldest genus of the family, *Alophota* (Pl. XXVI. fig 3), and with the more highly developed *Arethusa* (figs. 4–8). Recently Chun has published some interesting notes on young Physalidæ (**83**, p. 558).

The smallest and youngest *Cystonula*, which I observed in December 1866, is figured

in Pl. XXVI. fig. 1; it had a length of 4 mm. in the expanded, 2 mm. in the contracted state, and was very similar to the youngest larvæ figured by Huxley (9, pl. x. fig. 1). This young larva is a simple medusome, composed of an ovate pneumatophore (the transformed umbrella) and a spindle-shaped siphon with a distal mouth (the manubrium of the original Medusa); from the vesicular pedicle of the siphon, which connects it with the base of the pneumatophore, arises a single long tentacle; this is a simple cylindrical filament, beset on the dorsal side with a series of reniform cnidonodes, of the same structure as in the adult Physalidæ. The ovate pneumatosaccus (fig. 1, *pf*) exhibits an apical stigma (*po*), or a simple pore on the proximal pole of the longitudinal axis; this is the permanent opening of the original invagination. The cavity between the outer and inner walls of the pneumatophore (closed above around the stigma) is below in open communication with that of the pedicle, and by this with the cavities of the siphon as well as the tentacle. The inside of the siphon is covered with numerous black hepatic villi (*sv*); the margin of the mouth (expanded in fig. 1 as a square suctorial disc) armed with a series of cnidocysts (*ss*).

A second stage of *Cystonula*, 6 mm. in length, which I found recently in a preparation in the Challenger collection, and could not figure in Pl. XXVI. (already printed), is intermediate between figs. 1 and 2 of that Plate. It differed from the youngest stage (fig. 1) in the production of a pair of buds from the ventral side of the dilated siphon-pedicle (*a*), opposed to the dorsal tentacle (*t*). The posterior bud of this pair develops into the first secondary siphon, the anterior into the first palpon (or basal sac) with its tentacle. The dilated cavity between float (*pf*) and stomach (*sv*), from which the buds arise, becomes now much larger and corresponds to the common stem or trunk (*a*).

The third stage of *Cystonula* observed is figured in Pl. XXVI. fig. 2; its length in the expanded state was 8 mm. It is similar to the second form figured by Huxley, 10 mm. in length (9, pl. x. fig. 2). The slender pyriform trunk, with strongly inclined axis, encloses in its proximal (anterior) half the pneumatosac, filled with air (*pf*), and bears on its distal (posterior) end the protosiphon (the primary siphon or the manubrium of the original medusome, with its tentacle). This is separated by a wide interval from the central group, composed of three subequal cormidia which are attached to the middle third of the ventral median line of the vesicular trunk; each cormidium is composed of two sterile persons arising from a common stem, a siphon (with hepatic villi, *sv*, and a terminal mouth), and a mouthless palpon (or basal ampulla, with a long tentacle). Regarded from the standpoint of our Medusome Theory, this *Cystonula* is a primary medusome, which has produced by budding from its ventral side three pairs of secondary medusomes; these arise from the middle third of the trunk, or from that portion which is the enlarged pedicle of the protosiphon (fig. 1, *a*). The growing pneumatophore, which originally occupied the apical part of the primary larva, extends now more and more over its dorsal side, descending in a basal direction. The longi-

tudinal axis, originally subvertical, becomes in this way inclined more and more, and finally lies subhorizontally.

The further development of the Physalidæ is determined mainly by the multiplication of the cormidia on the ventral or inferior side of the vesicular trunk, and by the progressive extension of the pneumatosaccus along its dorsal or superior side. In *Alophota* and *Physalia*, where the single large main tentacle is much longer than all the others, usually the two groups of cormidia (the larger ventral and the smaller basal) remain separated, and their further development is different. The smaller basal group, at the posterior or distal end of the trunk, produces merely a series of small siphons and palpons, placed before the protosiphon, and is provided with a single tentacle only; it always remains sterile and never produces gonophores. The larger ventral group produces early a very large main tentacle, with a gigantic main palpon, much longer and stronger than all the others. The number of cormidia in this ventral group is much larger, and the siphons as well as the palpons and the accessory tentacles become very numerous in the larger species. Some of them afterwards produce gonodendra. In *Arethusa* and *Caravella*, on the other hand, the number of main tentacles increases, and usually the two groups of cormidia (smaller basal and larger ventral) are early united into a single large mass of crowded appendages. The succession and composition of the cormidia seem to follow, however, somewhat different laws in the various species of Physalidæ.

The further development of the pneumatophore in the larvæ of Physalidæ has recently been described by Chun (**83**, p. 559). The inferior or basal third of the invaginated pneumatosaccus becomes separated from the superior larger portion by an annular constriction. The cylinder-epithelium of the former is the pneumadenia, which afterwards expands in the form of a gas-secreting "basal plate" ("Luftplatte"). *Physalia* and *Caravella* afterwards develop the dorsal crest which is wanting in the float of *Alophota* and *Arethusa*.

Truncus.—The marked peculiarity in which the Physalidæ differ from all other Siphonophoræ, is the strange development of the hypertrophic pneumatophore along the dorsal side of the common trunk. The nectosome, therefore, occupies in this family the entire dorsal half of the corm, whereas the siphosome takes the ventral half; the main axis of the trunk becomes subhorizontal, whilst it is vertical in the other Siphonophoræ; the nectosome occupies in these latter the apical or proximal, the siphosome the basal or distal, part of the corm. The naked dorsal face of the trunk, which bears no appendages but includes the float, is in all Physalidæ much larger than the ventral face which bears the cormidia of the siphosome. The cavity of the trunk is wide, and when the gas is expelled through the stigma of the contracted float, the trunk appears as a voluminous sac filled with nutritive fluid. The trunk in the Physalidæ is never coiled up spirally as in the allied Epibulidæ.

Pneumatophore.—The gigantic float of the Physalidæ determines by its excessive

unilateral development along the dorsal side of the trunk, the peculiar form and the strange character of this family. Nevertheless the young larvæ (*Cystonula*, Pl. XXVI. fig. 1) are not essentially different from those of other Cystonectæ (*e.g.*, *Cystalia*, Pl. XXII. figs. 1–5). The float is here a relatively small ovate or ellipsoidal vesicle in the apical part of the primary medusome, connected by the inflated pedicle (*a*) with the basal protosiphon (*sa*). The stigma on its apical pole (*po*) is the permanent opening of invagination, from which the simple pneumatosac (or the inner float-wall) depends freely into the pneumatocodon (or the outer float-wall). Chun tells us that the float of these young larvæ has a complete radial structure ("ein völlig radialer gebauter ovaler Luftsack," **83**, p. 559); but I have never found in the Physalidæ (neither the youngest larvæ, nor older forms) any trace of radial structure; they possess neither the eight radial bunches of hypocystic villi which are found in the Epibulidæ (Pl. XXII. figs. 6–8), the Salacidæ (Pl. XXV. figs. 2, 3), and the Rhizophysidæ (Pl. XXIV. figs. 1–5), nor the corona of radial septa and pouches which is obvious in most Physonectæ. The pneumatosac of all Physalidæ lies freely in the voluminous cavity of the large pneumatocodon, and is connected with the latter only at the apical pole, by the sphincter of the stigma. The pericystic cavity, therefore, is as simple as in the Cystalidæ, Athoridæ, and Apolemidæ. The outer wall of the float is very thick and muscular, with an outer layer of strong, parallel, longitudinal fibres and an inner layer of circular ring-fibres. By compressing the float voluntarily, the animal can extrude the included air through the apical stigma, and sink down. After a short time has elapsed it can rise again, secreting a great mass of gas by the pneumadenia, and filling the float. I often observed this process repeated, in December 1866, off the Canary Islands. The lamellar pneumadenia, or the glandular "air-plate" ("Luftplatte," Chun, **83**, p. 569), which corresponds to the endocystic tapetum of the other Cystonectæ (p. 309), is a thin distal layer of exodermal glandular cylinder-cells, placed originally in the basal portion of the pneumatosac. It grows afterwards more towards the ventral side and extends forwards. It has a diameter of 4 mm. in a float 20 mm. in diameter. But in the adult *Caravella maxima* it reaches 100 to 150 mm. in diameter, and occupies nearly the ventral half of the pneumatophore.

Asymmetry of the Corm.—The fundamental form of the bilateral corm is in all mature Physalidæ more or less asymmetrical, either the left or the right side being more developed and organised differently from the opposite side. This asymmetry is less expressed in the crestless Arethusidæ (*Alophota*, *Arethusa*); it is much more prominent in the crest-bearing Caravellidæ (*Physalia*, *Caravella*). But the young monogastric larva (*Cystonula*, Pl. XXVI. fig. 1) is monaxonial, and only the tentacle arising from the ventral median line marks the bilateral symmetry. As soon as the budding of the secondary cormidia on the ventral side of the primary medusome commences, the subvertical axis of the latter becomes more and more inclined, and finally subhorizontal. The first trace of the asymmetrical development is then marked by the situation of the

different buds, the siphons on one side, and the palpons and tentacles on the other side; afterwards all the gonodendra lie on one side (right or left, figs. 3, 4). The more the trunk becomes inflated by the hypertrophied float, the more it lies on one side of the body. On the opposite side is developed the crest of the Caravellidæ, acting the part of a sail, similar to that of the Velellidæ. As in these latter, the unilateral situation of the sail (right or left) is accidental, and is not constant in the single species; but usually in each species (as with the eyes of the Pleuronectidæ) the majority have the crest on the same side (compare Chun, **83**, p. 576). The largest siphons and palpons, and the main tentacles, lie on this side (the lophopleura), while the gonodendra develop on the opposite side (the hypopleura). Compare L. Agassiz, **36**, p. 335. The different growth of the two antimeres (or body-halves) is in some *Physaliæ* (*e.g.*, *Physalia utriculus*, **77**, Tab. xxxv. fig. 2) so striking, that the median plane of the dorsal crest lies more horizontally than vertically, and the usual ovate or pyriform shape of the float becomes triangular; the distance between the anterior stigma (on the apical pole of the main axis) and the posterior protosiphon (on its basal pole), seen from above, is in this case often scarcely half as great on the lee-side, or the hypopleura (which bears the gonodendra), than on the windward-side or the lophopleura (which bears the crest). It must be remembered, however, that the free edge of the comb-like crest is always originally the dorsal median line of the asymmetrical trunk, and the line in which the cormidia bud the ventral median line. The anterior stigma marks constantly the apical pole of the longitudinal main axis, and the mouth of the posterior protosiphon its basal pole.

Crest of the Float.—The remarkable polythalamous comb-like crest of the pneumatophore, which is usually regarded as the most striking peculiarity of this family, is developed only in the larger Caravellidæ (*Physalia* and *Caravella*); it is wanting in the smaller Arethusidæ, which, because of their much smaller size and simpler form, have usually been overlooked (*Alophota* and *Arethusa*, Pl. XXVI.). It is wanting, also, in the younger larvæ of the Caravellidæ. The crest, therefore, is a secondary organ, got by adaptation to the sailing locomotion of the hydrostatic float. Regarded from a morphological point of view, it is nothing more than a simple longitudinal fold in the dorsal median line of the trunk. It becomes divided afterwards by a number of transverse septa into a series of triangular air-chambers. These have often been compared with the chambers in the polythalamous pneumatocyst of the Disconectæ. But this comparison is only a remote analogy, not a true homology. The morphological affinity which is suggested by most authors between Physalidæ and Velellidæ does not exist at all. On the structure of the crest and its relation to the float, compare Leuckart (**81**, p. 192), L. Agassiz (**36**, p. 335, pl. xxxv.), and Chun (**83**, p. 576). The number of the primary chambers in the crest of young Caravellidæ is three or four, in the older six to eight or more. These become divided by smaller transverse septa into secondary chambers, and these again by smaller

tertiary septa into chambers of the third (sometimes even of the fourth) order (compare Olfers, **79**, fig. 1; Leuckart, **81**, fig. 2; L. Agassiz, **36**, fig. 1, &c.). Possibly the number of these chambers corresponds to that of the cormidia, which arise in metameric succession from the opposite ventral side of the trunk; it is different in the various species. The Physalidæ are able to compress the float and the crest in a very variable manner, and to change their form in a most extraordinary degree. The external form of these hydrostatic organs, therefore, is of little value for the distinction of species.

Cormidia.—The numerous groups of polymorphous persons and organs which compose the corm of the Physalidæ are usually loose, and represent, especially in the larger species, a clustered mass of crowded parts, which seem to be aggregated without any regular order. A comparative examination, however, of the younger stages and larvæ, and especially of the small mature *Alophota* (Pl. XXVI. figs. 1–3), informs us that at the very beginning the cormidia are here also more or less ordinate. A single series of a few cormidia (four in *Cystonula*, fig. 2; six in *Alophota*, fig. 3; eight to ten in *Arethusa*, fig. 4) is here attached along the ventral median line of the trunk, and usually each of these cormidia (excepting the basal group at the distal end) is composed of a siphon, a palpon, and a tentacle; and in mature corms also of a gonodendron. The internodes of the trunk, or the free intervals between the succeeding cormidia, are very distinct in the smaller and younger forms (figs. 2, 3), whilst they disappear in the larger and older forms (figs. 4, 5). The cormidia of the former are originally monogastric (as in the Rhizophysidæ), whilst they become polygastric in the latter (as in the Salacidæ).

Basal Cormidium.—The distal end of the trunk, which is the posterior in the usual position of the corm (with horizontal main axis), bears in all Physalidæ a separate cormidium of special interest (figs. 3, 4, *su*). We call it the "basal cormidium," since it is placed at the base or the distal pole of the main axis, opposite to the apical stigma on its proximal pole (*po*). This primary or basal cormidium remains always sterile, and has a different morphological and physiological value from the numerous secondary cormidia which arise from the ventral side of the trunk and afterwards produce gonodendra. In the simplest case (fig. 3) the basal cormidium consists of a single siphon (*su*), a palpon (*g*), and a tentacle. The siphon placed at the very distal end, in the prolongation of the horizontal main axis, has the greatest morphological interest; it is the primary siphon of the youngest larva (fig. 1), and therefore the original manubrium of the primary medusome, the umbrella of which is the float; we call it the protosiphon or primary siphon, in order to distinguish it from all the other siphons, secondarily produced, or the metasiphons. The primary tentacle (fig. 1, *t*) which belongs to the protosiphon, remains either as the single tentacle of the basal cormidium, or it is afterwards lost; but I have never seen secondary tentacles developed in this distal group; usually it is composed afterwards of a series of small secondary siphons or palpons (twelve to twenty or more). The interval between the basal cormidium and the larger group of

ventral cormidia is in most Physalidæ permanent, sometimes larger, at other times smaller, than in *Alophota giltschiana*, fig. 3, *Physalia pelagica* (**77**, Tab. xxxv. fig. 2), &c.; it is lost afterwards in those species, in which the number of cormidia is exceedingly augmented, and all are confluent in a single crowded mass (as in *Arethusa challengeri*, figs. 4, 5, in *Caravella maxima*, and in *Physalia megalista*).

Ventral Cormidia.—The numerous secondary cormidia which compose the large main group of appendages, on the ventral side of the trunk, exhibit a great variety in number, size, composition, and arrangement. Possibly these differences are constant in different localities and possess therefore a systematic value; but they require a far more accurate anatomical examination than has been employed hitherto. Originally each secondary cormidium (in most species at least) seems to be monogastric, composed of a single siphon, a palpon, and a tentacle, and in small mature corms of a gonodendron (fig. 3); but usually the common pedicle of these medusomes afterwards branches, and produces a variable number of tertiary cormidia. Generally a single tentacle and the appertaining palpon, in the middle of the ventral group, becomes early much larger than all the others; this predominant main tentacle remains single in *Alophota* and *Physalia*, whilst a variable number of similar gigantic main tentacles (usually ten to twenty) is afterwards produced in *Arethusa* and *Caravella*. Many secondary cormidia remain sterile in most Physalidæ, and a small number only (usually eight to twelve) develop a large gonodendron. It may be, perhaps, that in the crest-bearing Physalidæ (*Physalia* and *Caravella*) the number of large primary air-chambers in the crest (usually eight to twelve) and their metameric succession often correspond to the segments of the trunk, from which arise the primary groups of ventral cormidia.

Siphons.—The feeding polypites exhibit in all Physalidæ the same shape, and are very similar to those of the Epibulidæ (Pl. XXII. fig. 6) and Salacidæ (Pl. XXV. fig. 5). The protosiphon (or the primary polypite of the basal cormidium) does not differ in structure from the numerous metasiphons (in the secondary cormidia of the large ventral group). The young siphons are simple spindle-shaped tubes, whilst the fully developed exhibit distinctly three or four different segments (Pl. XXVI. fig. 6). The two proximal segments, viz., the thin pedicle (*sp*) and the vesicular basigaster (*sb*), are usually small, and often confluent; the two distal segments, however, are always large and distinct. The stomach is a very dilatable sac, inside covered with numerous black hepatic villi (*sv*); the proboscis is a very muscular cylindrical tube, very contractile and expansible, and opens by a mouth, which may be expanded in the form of a circular or polygonal (often square) suctorial disc (fig. 1, *ss*); its margin is armed with a series of cnidocysts (compare on the structure of the siphons, Leuckart, **81**, Huxley, **9**, &c.).

Palpons.—All Physalidæ possess, intermingled with the mouth-bearing siphons, a larger number of mouthless palpons. These are of two kinds. The first kind exhibits the same structure as the siphons and differs only in the absence of a distal mouth-opening.

They arise partly from the pedicles of the cormidia, partly from the branches of the gonodendra; it may be that many of the former (or perhaps all?) are young siphons, which afterwards get a mouth-opening. Those which arise constantly from the branches of the gonodendra may be distinguished as gonopalpons (fig. 8, *q*). The second kind of palpon is connected with the tentacles, so that always a single tentacle (fig. 6, *t*) arises from a common pedicle with a single palpon (fig. 6, *to*). These tentacular palpons are simple, very contractile, cylindrical tubes, closed at the pointed distal end, whilst their proximal end opens into the common pedicle; they do not possess the hepatic villi of the first kind. Eschscholtz even compared them with the ampullæ of the ambulacral feet in Echinoderms (**1**, p. 158); Leuckart calls them "Tentakel-Bläschen" (**81**, p. 197), and Huxley describes them as basal sacs (**9**, p. 103). The physiological function of these basal ampullæ is, indeed, the same as those of the ambulacral ampullæ in the Echinoderms. The morphological value, however, is very difficult to make out. It may be that they are only secondary organs developed from the base of the tentacles, which originally belong to the siphons. On the other hand it is possible that originally a pair of siphons has arisen from a common pedicle; the first siphon has lost the tentacle and preserved the hepatic villi and the mouth; the second siphon, on the other hand, has lost the latter organs and preserved the tentacle. The incipient basal ampulla (fig. 7, *to*) is much larger than the young tentacle arising from its base (*t*).

Tentacles (figs. 1, 3, 6, *t*).—The long tentacles exhibit in all Physalidæ the same structure, accurately described by Huxley (**9**, p. 103, pl. x. figs. 11, 12). They are slender moniliform filaments, or rather ribbon-shaped tubes, and agree essentially with those of *Salacia* (Pl. XXV. fig. 5, *t*). Only the primary tentacle (fig. 1, *t*) arises directly from the base of the protosiphon; all the other (secondary) tentacles arise from a common pedicle with a siphon and a palpon (fig. 6); or more correctly speaking, the tentacle (*t*) and the tentacular palpon (*to*), closely united, have a common pedicle, which arises from the same stalk of the cormidium as the siphon. As stated above, the palpon (the basal sac or basal ampulla, *to*) bears to the tentacle the same physiological relation as the ambulacral ampullæ of Echinoderms to their feet. In form and structure the numerous slender accessory tentacles are the same as the single large main tentacle, which arises from the middle of the ventral group and surpasses the former ten to twenty times in thickness; its breadth reaches 3 to 6 mm. or more. Its length is usually more than a metre, but it may reach in the expanded state ten to twenty metres or even more, as in *Caravella maxima*. The ventral side of each tentacle bears a muscular suspensorium (similar to a ribbon-shaped mesentery), whilst the dorsal side is beset with a series of very numerous reniform cnidonodes. Each of the latter may be regarded as a kidney-shaped tentillum or lateral branch, since it contains a diverticulum of the tentacular canal. The thick dorsal wall of this cavity is filled with innumerable spherical cnidocysts.

Gonodendra (Pl. XXVI. figs. 3, 6, *g*, 8).—The corms of all Physalidæ are monœcious

and the cormidia monoclinic; each ultimate branch of the clustered gonodendra is monostylic, since it bears upon the same stalk a single female (*f*) and numerous male gonophores (*h*), intermingled with some gonopalpons (*q*). The structure of these single persons is the same as in the other Cystonectæ (compare above, p. 313). The number of gonodendra is usually four to six in the smaller, eight to twelve or more in the larger species; they are very richly branched, and arise from a common stalk with the siphons and palpons (fig. 6). In the largest species each gonodendron bears some thousands of gonophores. (Compare Huxley, **9**, p. 105, pl. x. figs. 14, 15, and Chun, **86**, p. 1168.) The club-shaped androphores (Pl. XXVI. fig. 8, *h*) come to sexual maturity whilst sessile on the stem, whilst the larger medusiform gynophores (fig. 8, *f*) become detached and produce ova as free-swimming Anthomedusæ.

Synopsis of the Genera of Physalidæ.

I. Subfamily ARETHUSIDÆ. Pneumatophore simple, without polythalamous dorsal crest.	A single large main tentacle,	74*a*. *Alophota*.
	Several large main tentacles,	74*b*. *Arethusa*.
II. Subfamily CARAVELLIDÆ. Pneumatophore provided with a dorsal crest, which is divided into a series of chambers by transverse septa.	A single large main tentacle,	75*a*. *Physalia*.
	Several large main tentacles,	75*b*. *Caravella*

Genus 74*a*. *Alophota*,[1] Brandt, 1835.

Alophota, Bdt., Prodromus, &c., **25**, p. 37.

Definition. — Physalidæ with a simple vesicular pneumatophore, without dorsal polythalamous crest. Siphosome with a single large main tentacle.

The genus *Alophota* and the following *Arethusa* compose together the subfamily Arethusidæ, differing from the following subfamily Caravellidæ in the absence of the peculiar polythalamous dorsal crest of the pneumatophore. This characteristic crest is also wanting in the young larvæ of the large-sized Caravellidæ; the small Arethusidæ, therefore, may be regarded as the ancestors of the former, or also as young Caravellidæ, which have reached sexual maturity in the larval form (Pædogenesis). In every case a crestless genus of Arethusidæ must have preceded in older times the crested Caravellidæ, much in the same way as the crestless *Rataria* has preceded the crested *Velella*. The crest of the pneumatophore, as an adaptation subservient to sailing, is a secondary acquisition of later times.

The genus *Alophota* was established by Brandt (**25**, p. 37) for a small crestless Physalid from the Tropical Atlantic. Comparing the good figure which Mertens has left

[1] *Alophota* = Without crest, ἀλόφωτα.

of it, I find that it differs from two other forms which I have myself observed living, *Alophota giltschiana*, from the Canary Islands (Pl. XXVI. figs. 1–3), and *Alophota mertensii*, from the Indian Ocean. The description of the latter will be published in my Morphology of the Siphonophoræ.

Alophota giltschiana, n. sp. (Pl. XXVI. figs. 1–3).

Habitat.—North Atlantic; Canary Islands, Lanzerote, December 25, 1866 (Haeckel).

Corm (fig. 3, lateral view of the mature corm, from the right side; fig. 1, a young, monogastric, larva; fig. 2, an older, polygastric, larva).—The largest corms observed which possessed gonodendra at the base of the siphons had a diameter of 15 to 20 mm., and were of a greenish-blue colour. The common trunk and the basal ampullæ of the tentacles were light greenish, the pneumatosaccus, the siphons, and the tentacles blue, the siphons with numerous black patches—the hepatic villi. The colour of the ripe gonodendra (placed on the right side) was yellowish. The body of the young larvæ, without gonodendra (figs. 1, 2), was entirely blue-coloured, or with a few greenish portions here and there. The smallest larva observed (fig. 1) was monogastric, 4 mm. long and 1 mm. thick, and had a pneumatophore 1 mm. in length. This *Cystonula* was in the contracted state very similar to that figured by Huxley of *Physalia* (9, pl. x. fig. 1).

Pneumatophore.—The expanded float of the ripe corm (fig. 3) is ovate, with sub-horizontal axis. The apical or anterior pole is pointed and bears the stigma or the opening for the emission of gas (fig. 3, *po*). The opposite basal or posterior pole is rounded and bears the protosiphon, or the primary polypite of the larva (*su*), and attached to its base a single tentacle with a basal ampulla. This distal or primary cormidium is separated by a broad interval (the basal internode) from the ventral group of ordinate cormidia, which form a single series in the ventral median line of the pneumatophore; they occupy only the middle third of its ventral side, whilst the anterior third and the posterior third (or the basal internode) are naked and free, without appendages.

Cormidia.—The number of secondary cormidia which compose the ventral group is in the specimen figured (fig. 3) four, besides a young one undeveloped. Each cormidium (fig. 6) is composed of four different organs, arising from a common pedicle, viz., (1) a blue siphon, with black hepatic villi and a terminal mouth; (2) a long blue tentacle (*t*); (3) a light greenish spindle-shaped basal ampulla (*to*) arising from its base; and (4) a small clustered monostylic gonodendron (*g*). The structure of all these parts is the usual one, as described above (pp. 345–347). The second tentacle and ampulla (counting from the apex) are far larger than those of the other cormidia. The size of this main tentacle and of the appertaining central siphon was in a second specimen (bearing six mature cormidia) comparatively much larger.

Genus 74*b*. *Arethusa*,[1] Haeckel, 1888.

Definition.—Physalidæ with a simple vesicular pneumatophore, without dorsal polythalamous crest. Siphosome with several large main tentacles of about equal size.

The genus *Arethusa* was established a century ago (in 1789) by Patrick Browne, for that gigantic Physalid of the Tropical Atlantic, which is known to the sailors as the "Portuguese Man-of-War," and which O. F. Müller and Gmelin had called *Medusa caravella* (afterwards *Salacia*), the type of our genus *Caravella* (Genus 75*b*). Since the generic name *Arethusa* was afterwards given up and replaced by Lamarck's name *Physalia*, we employ here the former for the designation of those Physalidæ which agree with *Caravella* in the possession of numerous large main tentacles, but differ from it in the absence of a polythalamous crest on the pneumatophore. *Arethusa* exhibits, therefore, the same relation to *Caravella* as the crestless *Alophota* bears to the crested *Physalia*.

Two different species of *Arethusa* were observed by me; the first, *Arethusa thalia* (from the Indian Ocean), is similar to *Alophota giltschiana* (Pl. XXVI. fig. 3), and exhibits a free interval between the single basal cormidium at the distal end of the trunk and the central group of loose cormidia on its ventral side. The second species (inhabiting the Atlantic, and figured in Pl. XXVI. figs. 4–8) does not exhibit that interval, but all the cormidia form together a single large group in the posterior half of the ventral side of the trunk.

Arethusa challengeri, n. sp. (Pl. XXVI. figs. 4–8).

Habitat.—North Atlantic, Station 354, May 6, 1876; lat. 32° 41′ N., long. 36° 6′ W.; surface.

Canary Islands, Lanzerote; December 1866 (Haeckel).

Corm (fig. 4, lateral view of the mature corm from the right side, in the expanded state; fig. 5, from the left side, in the contracted state).—The largest corms observed which possessed gonodendra at the base of the siphons had a length of 40 mm. to 50 mm. The colour of the corm was greenish-blue; the common trunk and the basal ampullæ light greenish, their tops often reddish; the siphons dark blue, with black villi, their proboscis often reddish; the tentacles partly blue, partly purple. The clustered gonodendra (placed on the right side) had a reddish colour.

Pneumatophore (figs. 4, 5, *pf*).—The float filled with air occupies the greatest part of the trunk; it exhibits as usual very different forms, according to the variable state of contraction. The longitudinal axis is subhorizontal. The outer wall (pneumatocodon) is separated from the inner wall (pneumatosac) by the cavity of the trunk, which is rather wide and sacciform in the posterior half, and especially on the ventral side. The

[1] *Arethusa* = Ἀρέθουσα, a Nymph, daughter of Nereus.

apex of the float (or the anterior top) exhibits a beak-shaped, very mobile apophysis, the apical rostrum; and at the upper side of its base is the stigma, or the air-pore (*po*).

Cormidia.—The posterior half of the ventral side of the trunk bears a continuous series of densely clustered cormidia, of the same shape as in the younger and smaller forms of *Caravella maxima*. Each fully developed cormidium (fig. 6) bears on a common short cylindrical pedicle (*ap*) four different organs, viz., (1) a blue siphon with black hepatic villi (*sv*) and a distal mouth (*so*); (2) a long blue or red tentacle beset with a series of reniform cnidonodes (*t*); (3) a slenderly spindle-shaped, light greenish basal ampulla (*to*) arising from its base; and (4) a clustered, yellowish or reddish, monostylic gonodendron of the usual composition (p. 313). The structure of all these parts is the same as in the other Physalidæ, as described above (pp. 345–347).

A variable number of main tentacles (usually six to eight) are far larger than the others, besides the young and undeveloped ones. The primary basal siphon (or the protosiphon, fig. 4, *su*), at the distal end of the trunk, is of the same form and size as the secondary siphons (in the ventral side), but is sterile and bears no gonodendron. Between it and the lowermost (oldest) secondary siphon is a group of small pyriform palpons (without tentacles). This group fills the interval (or the basal internode), which is free and naked in *Alophota* (Pl. XXVI. fig. 3).

Genus 75*a*. *Physalia*,[1] Lamarck, 1816.

Physalia, Lamarck, Hist. nat. des anim. sans vert., tom. ii. p. 478.

Definition.—Physalidæ with a polythalamous crest on the dorsal side of the large vesicular pneumatophore. Siphosome with a single large main tentacle.

The genus *Physalia* and the following *Caravella* make up together the subfamily Caravellidæ, differing from the preceding subfamily Arethusidæ in the possession of that peculiar dorsal crest of the pneumatophore, which is divided by numerous vertical transverse septa into a series of air-filled triangular chambers. All Physalidæ belonging to the Caravellidæ attain a far larger size and bear a far greater number of organs in their loose cormidia than the preceding Arethusidæ. The genus *Physalia*, in the stricter definition here offered, comprises the greater number of species hitherto described. It bears only a single large main tentacle, much longer and thicker than the numerous accessory tentacles, and differs by this constant character from the following *Caravella*, provided constantly with a greater number of subequal strong main tentacles (usually ten to twenty or more). *Physalia* bears therefore the same relation to *Caravella* as the crestless *Alophota* does to *Arethusa*.

The accurate distinction and sharp definition of the numerous species of *Physalia* which have been described is a very difficult task, owing partly to the numerous transitional

[1] *Physalia* = Sea-bladder, φῦσα, ἁλία.

forms, which connect the different "good species" of this transformistic group, partly to the great confusion of the voluminous literature on this subject. Most authors have founded their specific distinctions upon slight differences in the variable form of the very contractile pneumatophore and insignificant varieties of colour. The accurate anatomical examination of the siphosome, the composition of the cormidia, and the relations of the different clustered medusomes has been much neglected, and requires a further more critical comparison (compare Huxley, **9**, p. 99, and Chun **83**, p. 557). Judging from the extended observations of numerous Physaliæ collected in different seas which I have been able to compare recently, I think that the following four species of *Physalia* may be distinguished provisionally:—(1) *Physalia pelagica* (South Atlantic); (2) *Physalia cornuta* (Indian Ocean); (3) *Physalia utriculus* (Pacific); and (4) *Physalia megalista* (Indian Ocean and South Atlantic).

Physalia megalista, Lamk. (Péron, **14**, pl. xxix. fig. 1), differs from the three other species in the complete union of all the cormidia, as in *Caravalla maxima;* there is wanting here the free interval which separates the small basal cormidium (on the distal end of the trunk) from the main mass of clustered cormidia on the ventral side of the pneumatophore. This interval between the two groups of cormidia (the smaller posterior and the larger anterior), as well as the composition of these cormidia, is different in the three other species of *Physalia;* the structure, too, of the pneumatophore, the number of chambers in its crest, and the mode of attachment of the appendages to the trunk, seem to offer marks for a more accurate distinction of these species. (Compare the figures of the Southern Atlantic *Physalia pelagica* by Eysenhardt, **77**, p. 45, Tab. xxxv. fig. 2; of the Indian *Physalia cornuta* by Tilesius, **76**, p. 42; and of the Pacific *Physalia utriculus* by Eschscholtz, **1**, p. 163, Taf. xiv. figs. 2, 3; and in Cuvier's Règne Animal Illustré, Zoophytes, pl. 58, fig. 4.)

Genus 75*b*. *Caravella*,[1] Haeckel, 1888.

Definition.—Physalidæ with a polythalamous crest on the dorsal side of the large vesicular pneumatophore. Siphosome with several large main tentacles of about equal size.

The genus *Caravella* comprises those Physalidæ which agree in the possession of a polythalamous crest on the dorsal side of the large pneumatophore with the preceding true *Physalia* (*s. restr.*), but differ from them in the possession of numerous large main tentacles, besides a great number of small accessory tentacles (or palpacles). *Caravella* exhibits therefore the same relation to *Physalia* which the crestless *Arethusa* bears to *Alophota*. The cormidia are in *Caravella* polygastric and loose; the number of siphons

[1] *Caravella*, the old name of *Physalia* as usually employed by the Italian and Spanish sailors (*Medusa caravella*, Linné).

and tentacles very great; usually ten to twenty very large tentacles are intermingled with forty to sixty or more small ones. The size, too, of the pneumatophore is in this genus larger than in all other Physalidæ and in all Siphonophoræ in general; its length attains in the largest specimens, fully expanded, 20 to 30 cm. or even more, its greatest breadth 8 to 10 cm.; the largest tentacles, fully expanded, attain a length of 20 to 30 metres or even more (40 to 50 feet, L. Agassiz, **36**, p. 336).

Two species only of *Caravella* may be distinguished in our present incomplete knowledge of this genus, both inhabiting the Atlantic Ocean. The smaller species is *Caravella gigantea* (=*Physalia gigantea*, Bory, *Physalia cystisoma*, Lesson, *partim*); it occurs sometimes in the Southern Atlantic, and seems to be transported from there occasionally by westerly winds into the Indian Ocean. Captain Rabbe collected it between Madagascar and the Cape of Good Hope. All parts of the body are smaller and more delicate than in the following species. The number of large main tentacles is four to eight, rarely more. But the principal difference is found in the isolated position of the basal cormidium, which is placed at the distal end of the trunk. It is isolated by a wide interval from the voluminous main mass of clustered cormidia, which occupies the smaller posterior half of the ventral side of the trunk. The predominant colour seems to be in *Caravella gigantea* more purple and violet, in *Caravella maxima* more blue and greenish; it is subject, however, to many variations.

The larger species, and the largest of all the Physalidæ, is the well-known *Caravella maxima*, which inhabits in great numbers the Tropical and Subtropical Atlantic, and especially the Gulf Stream. I observed it in great numbers during my residence in the Canary Islands, in December 1866 and January 1867, and also returning from there, in the Straits of Gibraltar, particularly in the Bay of Algesiras (in March 1867). It is also occasionally driven by westerly winds into the Mediterranean, which it seems not to inhabit permanently; several specimens are observed in single years on the shores of Italy (Naples, Messina, &c.). *Caravella maxima* has been described as *Medusa caravella* by O. F. Müller and Gmelin, as *Physalia caravella* by Eschscholtz (**1**, p. 160, Taf. xiv. fig. 1). Numerous later authors have figured it under the name *Physalia arethusa*, as for example Tilesius, Chamisso, Olfers (**79**, Taf. i., ii.), and L. Agassiz (**36**, pl. xxxv.). Lamarck and Lesson (**3**, pl. xi.) call it *Physalia pelagica*. (For the synonymy and history of this celebrated species, compare Olfers and Lesson, *loc. cit.*) *Caravella maxima* is easily distinguished from the allied *Caravella gigantea* by the union of the basal cormidium with the other cormidia, all forming together a single clustered mass of crowded appendages, which covers the greater (posterior) half of the ventral side down to its basal apex. On its motions and habits, compare Olfers (**79**) and L. Agassiz (**36**, p. 336). The young larvæ of *Caravella maxima*, which I observed at Christmas 1866 in Lanzerote, are very similar to those figured in Pl. XXVI. figs. 1, 2 (*Cystonula*).

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95. 1888. Haeckel, Ernst, System der Siphonophoren, auf phylogenetischer Grundlage entworfen. *Jenaische Zeitschrift*, Bd. xx. p. 1. (A separate edition of this paper, the general part of which is translated as the Introduction to this Report, was published in December 1887.)

LIST OF FAMILIES, GENERA, AND SPECIES.

N.B.—This list is a complete catalogue of all the genera and species of Siphonophoræ hitherto described with sufficient evidence (from 1775 to 1888); the doubtful or insufficiently characterised species are marked by a query. Those new species, which are followed by the words "Morph. Siphon.," will be described afterwards in my *Morphologie der Siphonophoren.*

Order I. DISCONECTÆ, Haeckel (System, **95**, p. 29).

Family I. DISCALIDÆ, Haeckel (System, **95**, p. 29).

Genus 1. *Discalia*, Hkl. (**95**, p. 29).

1. *Discalia medusina*, Hkl. (Report, p. 46, Pl. XLIX. figs. 1–6). South Pacific, Station 288.
2. *Discalia primordialis*, Hkl. (Report, p. 46). Tropical Pacific, Station 274.

Genus 2. *Disconalia*, Hkl. (**95**, p. 30).

3. *Disconalia gastroblasta*, Hkl. (Report, p. 48, Pl. XLIX. figs. 7–12; Pl. L.). South Pacific, Station 181.
4. *Disconalia pectyllis*, Hkl. (Morph. Siphon.). Indian Ocean, Station 157.
5. *Disconalia ramifera*, Hkl. (?) (=*Porpita ramifera*, Eschscholtz?, **1**, p. 178, Taf. xvi. fig. 3). Tropical Pacific (?).

Family II. PORPITIDÆ, Brandt (**25**, p. 40).

Genus 3. *Porpalia*, Hkl. (**95**, p. 30).

6. *Porpalia prunella*, Hkl. (Report, p. 58, Pl. XLVIII.). Tropical Pacific, Station 222.
7. *Porpalia globosa*, Hkl. (=*Porpita globosa*, Esch., **1**, p. 178, Taf. xvi. fig. 4). Tropical Atlantic (near the Cape Verde Islands).

Genus 4. *Porpema*, Hkl. (**95**, p. 30).

8. *Porpema medusa*, Hkl. (Report, p. 61, Pl. XLVII.). South Atlantic, Station 327.
9. *Porpema lenticula*, Hkl. (Morph. Siphon.). Indian Ocean.
10. *Porpema pileata*, Hkl. (Morph. Siphon.). South Pacific (coast of Chili).

Genus 5. *Porpitella*, Hkl. (**95**, p. 30).

11. *Porpitella pectanthis*, Hkl. (Report, p. 64, Pl. XLVI.). North Pacific, Station 244.
12. *Porpitella cærulea*, Hkl. (=*Porpita cærulea*, Esch., **1**, p. 179, Taf. xvi. fig. 5). Tropical Pacific.
13. *Porpitella radiata*, Hkl. (=*Porpita radiata*, Brandt, **25**, p. 40). Tropical Pacific.

Genus 6. *Porpita*, Lamarck (**90**, p. 483).

14. *Porpita mediterranea*, Esch. (**1**, p. 177). Oldest description and figure by Forskål (**11**, p. 103, Tab. xxvi. fig. L, 1). Best description and figure by Kölliker (**4**, p. 57, Taf. xii.). Mediterranean.
15. *Porpita linnæana*, Lesson (**3**, p. 588). Best description and figure by Alex. Agassiz (**57**, p. 12, pls. vii.–xii.). North Atlantic.
16. *Porpita umbella*, Esch. (**1**, p. 179=*Porpita gigantea*, Péron, **14**, pl. xxxi. fig. 6). Tropical Atlantic (?).
17. *Porpita indica*, Hkl. (=*Porpita lütkeana* ?, Brandt, **25**, p. 41). Indian Ocean.
18. *Porpita fungia*, Hkl. (Report, p. 67, Pl. XLV.). North Pacific, Stations 253 to 255.
19. *Porpita pacifica*, Lesson (**22**, pl. vii. fig. 3). Tropical Pacific (near Peru) (?).
20. *Porpita australis*, Hkl. (Morph. Siphon.). South Pacific.

Family III. VELELLIDÆ, Esch. (**1**, p. 165).

Genus 7. *Rataria*, Esch. (**1**, p. 166).

21. *Rataria cristata*, Hkl. (Report, p. 79, Pl. XLIV.). Tropical Atlantic, Station 348.
22. *Rataria mitrata*, Esch. (**1**, p. 168, Taf. xvi. fig. 2). Tropical Atlantic, off the Cape Verde Islands (?).
23. *Rataria cordata*, Esch. (**1**, p. 167, Taf. xvi. fig. 1). North Atlantic (?).

Genus 8. *Velella*, Lamarck (**90**, p. 481).

24. *Velella spirans*, Esch. (**1**, p. 172=*Velella limbosa*, Lamk., **90**). Oldest description and figure by Forskål (**11**, p. 104, Tab. xxvi. fig. *k*). Best description and figure by Kölliker (**4**, p. 46, Taf. xi. figs. 9–15). Mediterranean.

25. *Velella caurina*, Esch. (**1**, p. 173, Taf. xv. fig. 2). North Atlantic.
26. *Velella scaphidia*, Péron et Lesueur (**14**, p. 44, pl. xxx. fig. 6). Tropical and South Atlantic, Stations 346–352.
27. *Velella oblonga*, Chamisso (**16**, p. 363, Tab. xxxii. fig. 2). Northern and Tropical Pacific (Stations 229–237).
28. *Velella pacifica*, Esch. (**1**, p. 174, Taf. xiv. fig. 4). North Pacific.
29. *Velella patella*, Brdt. (**25**, p. 38). Tropical Pacific (Stations 265–279).
30. *Velella cyanea*, Lesson (**22**, p. 54, pl. vi. figs. 3, 4). South Pacific (?).

Genus 9. *Armenista*, Hkl. (Report, p. 83).

31. *Armenista mutica*, Hkl. (= *Velella mutica*, Lamk.). Best description and figures by Alex. Agassiz (**57**, p. 2, pls. i.–vi.). North Atlantic.
32. *Armenista sigmoides*, Hkl. (Report, p. 84, Pl. XLIII.). Tropical Atlantic and South Atlantic, Station 346.
33. *Armenista indica*, Hkl. (= *Velella indica*, Esch., **1**, p. 175, Taf. xv. fig. 5). Indian Ocean.
34. *Armenista antarctica*, Hkl. (= *Velella antarctica*, Esch. = *Velella sinistra*, Chamisso, **16**, p. 363, Tab. xxxii. fig. 1). Indian Ocean, Antarctic Ocean, Cape of Good Hope.
35. *Armenista lata*, Hkl. (= *Velella lata*, Chamisso, **16**, p. 364, Tab. xxxii. fig. 3). North Pacific.
36. *Armenista lobata*, Hkl. (Morph. Siphon.). South Pacific (?).

Order II. CALYCONECTÆ, Haeckel (System, **95**, p. 31).

Family IV. EUDOXIDÆ, Hkl. (System, **95**, p. 32).

Genus 10. *Diplophysa*, Ggbr. (**7**, p. 291).

37. *Diplophysa inermis*, Ggbr. (**7**, p. 291, Taf. xvi. fig. 3 = Eudoxia of *Sphæronectes gracilis*, Hkl.). Mediterranean.
38. *Diplophysa köllikeri*, Hkl. (Report, p. 108) (= Eudoxia of *Sphæronectes köllikeri*, Hxly.). Indian Ocean and Tropical Pacific, Station 274 (?).

Genus 11. *Eudoxella*, Hkl. (Report, p. 108).

39. *Eudoxella galea*, Hkl. (Report, p. 108, Pl. XXXII.). Tropical and Subtropical Atlantic (?).
40. *Eudoxella didyma*, Hkl. (Morph. Siphon.). Tropical Atlantic, Station 343 (?).

Genus 12*a*. *Cucubalus*, Blainv. (**24**, p. 130).

41. *Cucubalus eschscholtzii*, Hkl. (= *Eudoxia eschscholtzii*, Busch, **67**, p. 33, Taf. iv., v.; Chun, **86**, Taf. xvii. fig. 3). Mediterranean.
42. *Cucubalus pyramidalis*, Hkl. (= *Ersæa pyramidalis*, Will, **65**, Taf. ii.). Mediterranean, Atlantic, Stations 348, 352 (?).
43. *Cucubalus cordiformis*, Quoy et Gaim. (**2**, pl. iv. pp. 24–27). Tropical Pacific (?).

Genus 12*b*. *Cucullus*, Lesson (**3**, p. 458).

44. *Cucullus campanula*, Hkl. (=*Eudoxia campanula*, Leuckart, **5**, p. 43, Taf. iii. figs. 16–20). Mediterranean.
45. *Cucullus gegenbauri*, Hkl. (=*Eudoxia messanensis*, Ggbr., **7**, Taf. xvi. fig. 4). Mediterranean.
46. *Cucullus subtilis*, Hkl. (=*Ersæa elongata*, Will, **65**, p. 82, Taf. ii. fig. 30). Mediterranean.
47. *Cucullus elongatus*, Hkl. (Morph. Siphon.) (=*Eudoxia elongata*, Hkl.). Atlantic.
48. *Cucullus lessonii*, Hkl. (=*Eudoxia lessonii*, Esch., **1**, p. 126, Tab. xii. fig. 2). Tropical Pacific.
49. *Cucullus gracilis*, Hkl. (Morph. Siphon.) (=*Eudoxia bojani*, Hxly., **9**, p. 59, pl. iii. fig. 7). Indian Ocean.

Genus 13. *Cuboides*, Quoy et Gaimard (**20**, p. 19).

50. *Cuboides vitreus*, Quoy et Gaim., **20**, pl. ii. E, figs. 1–3. Mediterranean.
51. *Cuboides crystallus*, Hkl. (Report, p. 112, Pl. XLII.). Tropical and Subtropical Atlantic, Station 352.
52. *Cuboides vogtii*, Hkl. (=*Cuboides vitreus*, Hxly., **9**, p. 63, pl. iv. fig. 5). Tropical Pacific.
53. *Cuboides nacella*, Hkl. (Morph. Siphon.). Indian Ocean.

Genus 14. *Amphiroa*, Blainv. (**24**, p. 133).

54. *Amphiroa trigona*, Hkl. (=*Eudoxia trigonæ*, Ggbr., **10**, Taf. xxviii. figs. 9–12). Mediterranean.
55. *Amphiroa carina*, Hkl. (Report, p. 114, Pl. XXXVI.). Tropical Atlantic, Station 348.
56. *Amphiroa alata*, Hxly. (**9**, p. 64, pl. v. fig. 1). Indian Ocean and Tropical Pacific.
57. *Amphiroa angulata*, Hxly. (**9**, p. 64, pl. v. fig. 2). South Pacific (?).

Genus 15. *Sphenoides*, Huxley (**9**, p. 61).

58. *Sphenoides tetragona*, Hkl. (Morph. Siphon.). Indian Ocean.
59. *Sphenoides obeliscus*, Hkl. (Report, p. 116, Pl. XXXVIII.). North Atlantic.
60. *Sphenoides perforata*, Hkl. (compare *Bassia perforata*, Hkl.). Tropical Atlantic.
61. *Sphenoides australis*, Hxly. (**9**, p. 62, pl. iv. fig. 4). South Pacific.

Genus 16. *Aglaisma*, Esch. (**1**, p. 129).

62. *Aglaisma eschscholtzii*, Hxly. (**9**, p. 60, pl. iv. fig. 2, =*Eudoxia pentagonæ*, Ggbr., **7**, Taf. xvi. figs. 1, 2). Mediterranean.
63. *Aglaisma gegenbauri*, Hkl. (Report, p. 119, Pl. XL.). Tropical and Subtropical Atlantic, Station 346.
64. *Aglaisma elongata*, Hxly. (**9**, p. 61, pl. iv. fig. 3). Tropical Pacific.

Family V. ERSÆIDÆ, Haeckel (**95**, p. 33).

Genus 17*a*. *Ersæa*, Esch. (**1**, p. 127).

65. *Ersæa gaimardi*, Esch. (**1**, Taf. xii. fig. 4). Mediterranean (?).
66. *Ersæa compressa*, Hkl. (Report, p. 123, Pl. XXXIV.). Tropical and Subtropical Atlantic, Stations 348, &c.
67. *Ersæa dispar*, Hkl. (= *Eudoxia bojani*, Esch., **1**, p. 125, Taf. xii. fig. 1). Tropical Pacific (?).

Genus 17*b*. *Lilæa*, Hkl. (Report, p. 124).

68. *Lilæa medusina*, Hkl. (Morph. Siphon.). Indian Ocean.

Family VI. MONOPHYIDÆ, Claus (**70**, p. 29).

Subfamily 1. SPHÆRONECTIDÆ, Huxley (**9**, p. 50).

Genus 18. *Monophyes*, Claus (**70**, p. 29).

69. *Monophyes princeps*, Hkl. (Report, p. 129, Pl. XXVII. figs. 13, 14). Indian Ocean.
70. *Monophyes hydrorrhoa*, Hkl. (= *Sphæronectes hydrorrhoa*, Hkl., **95**, p. 34). Tropical Atlantic (?).
71. *Monophyes diptera*, Hkl. (= *Monophyes gracilis*, larva, Chun, **87**, Taf. ii. fig. 5). Mediterranean (?).
72. *Monophyes irregularis*, Claus (**70**, p. 29, Taf. iv. figs. 16–18). Mediterranean.

Genus 19. *Sphæronectes*, Huxley (**9**, p. 50).

73. *Sphæronectes köllikeri*, Hxly. (**9**, p. 50, pl. iii. fig. 4). Indian Ocean and Tropical Pacific.
74. *Sphæronectes gracilis*, Hkl. (= *Monophyes gracilis*, Claus, **70**, p. 29, Taf. iv. figs. 8–14; Chun, **87**, Taf. ii. figs. 1, 2). Mediterranean.

Genus 20. *Mitrophyes*, Hkl. (**95**, p. 34).

75. *Mitrophyes peltifera*, Hkl. (Report, p. 131, Pl. XXVIII.). Tropical and North Atlantic, Station 352.

Subfamily 2. CYMBONECTIDÆ, Hkl. (**95**, p. 34).

Genus 21. *Cymbonectes*, Hkl. (**95**, p. 34).

76. *Cymbonectes huxleyi*, Hkl. (Report, p. 134, Pl. XXVII. figs. 1–12). Indian Ocean.
77. *Cymbonectes mitra*, Hkl. (= *Diphyes mitra*, Huxley, **9**, p. 36, pl. i. fig. 4). Indian Ocean.
78. *Cymbonectes cymba*, Hkl. (Morph. Siphon.). Tropical Atlantic (?).

Genus 22. *Muggiæa*, Busch (**67**, p. 48).

79. *Muggiæa kochii*, Chun (**86**, Taf. xvii. fig. 2). Mediterranean.
80. *Muggiæa pyramidalis*, Busch (**67**, p. 48). North Atlantic (?).
81. *Muggiæa chamissonis*, Hkl. (=*Diphyes chamissonis*, Hxly., **9**, p. 36, pl. i. fig. 3). Tropical Pacific.

Genus 23. *Cymba*, Esch. (**1**, p. 133).

82. *Cymba enneagonum*, Esch. (=*Enneagonum hyalinum*, Quoy et Gaim., **2**, pl. v. figs. 1–6). Mediterranean.
83. *Cymba crystallus*, Hkl. (Report, p. 138, Pls. XLI., XLII.). Tropical Atlantic, Station 348.
84. *Cymba vogtii*, Hkl. (=*Abyla vogtii*, Hxly., **9**, p. 46, pl. ii. fig. 3). Tropical Pacific.
85. *Cymba nacella*, Hkl. (Morph. Siphon.). Indian Ocean.

Family VII. DIPHYIDÆ, Esch. (**1**, p. 122).

Subfamily 1. PRAYIDÆ, Kölliker (**4**, p. 33).

Genus 24. *Praya*, Blainv. (**24**, p. 137).

86. *Praya maxima*, Ggbr. (**7**, p. 301, Taf. xvii. figs. 1–6). Mediterranean.
87. *Praya cymbiformis*, Chiaje (**18**; Leuck., **5** and **8**). Mediterranean, North Atlantic.
88. *Praya galea*, Hkl. (Report, p. 146, Pls. XXXI., XXXII.). Tropical Atlantic, Station 352.

Genus 25. *Lilyopsis*, Chun (**87**, p. 18).

89. *Lilyopsis diphyes*, Chun (**87**, =*Praya diphyes*, Vogt, **6**, pls. xvi., xvii.; Kölliker, **4**, Taf. ix.). Mediterranean.
90. *Lilyopsis medusa*, Chun (**87**, =*Praya medusa*, Metschnikoff, in an inaccessible Russian paper). Mediterranean.
91. *Lilyopsis rosea*, Chun (**87**, Taf. ii. figs. 12, 13). Mediterranean.
92. *Lilyopsis catena*, Hkl. (Report, p. 150). North Atlantic.

Subfamily 2. DIPHYOPSIDÆ, Hkl. (Report, p. 145).

Genus 26. *Galeolaria*, Blainv. (**24**, p. 139).

93. *Galeolaria aurantiaca*, Vogt, (**6**, p. 110, pls. xviii., xix.; =*Sulculeolaria quadrivalvis*, Blainv., **24**, p. 138; =*Epibulia aurantiaca*, Vogt, **6**, p. 110). Mediterranean.
94. *Galeolaria turgida*, Hkl. (=*Diphyes turgida*, Ggbr., **68**, p. 442, Taf. xxiii.). Mediterranean.
95. *Galeolaria biloba*, Blainv. (Sars, **27**, Heft i. p. 41, Taf. vii. figs. 16–21). North Atlantic.

96. *Galeolaria truncata*, Hxly. (**9**, p. 38; = *Diphyes truncata*, Sars, **27**, Heft i. Taf. vii. figs. 1–15). North Atlantic.
97. *Galeolaria sarsii*, Hkl. (= *Diphyes sarsii*, Ggbr., **10**, p. 30, Taf. xxx. figs. 30, 31). Arctic.
98. *Galeolaria australis*, Blainv. (**24**, p. 139; Huxley, **9**, p. 38, pl. iii. fig. 5). Indian Ocean.
99. *Galeolaria stephanomia*, Hkl. (= *Diphyes stephanomia*, Mert., **25**, p. 32). Tropical Pacific.

Genus 27. *Diphyes*, Cuvier (**91**, p. 61).

100. *Diphyes acuminata*, Leuck. (**5**, Taf. iii. figs. 11–19, and **8**, Taf. xi. figs. 11–13). Mediterranean.
101. *Diphyes sieboldii*, Köll. (**4**, p. 36, Taf. xi.). Mediterranean.
102. *Diphyes subtilis*, Chun (**88**, p. 681). Mediterranean.
103. *Diphyes elongata*, Hyndman (**64**, p. 166). North Atlantic (?).
104. *Diphyes appendiculata*, Esch. (**1**, Taf. xii. fig. 7). Pacific Ocean.
105. *Diphyes gracilis*, Hkl. (Morph. Siphon.). Indian Ocean.

Genus 28. *Diphyopsis*, Hkl. (**95**, p. 35).

106. *Diphyopsis campanulifera*, Hkl. (= *Diphyes campanulifera*, Quoy et Gaim., **20**, pl. i. fig. 7; **1**, p. 137). Mediterranean.
107. *Diphyopsis compressa*, Hkl. (Report, p. 153, Pls. XXXIII., XXXIV.). Tropical Atlantic, Stations 327, &c.
108. *Diphyopsis dispar*, Hkl. (= *Diphyes dispar*, Chamisso, **16**, Tab. xxxiii. fig. 4). Tropical Pacific.
109. *Diphyopsis angustata*, Hkl. (= *Diphyes angustata*, Esch., **1**, p. 136, Taf. xii. fig. 6). Tropical Pacific (?).

Subfamily 3. Abylidæ, L. Agassiz (**36**, p. 372).

Genus 29. *Abyla*, Quoy et Gaim. (**20**, p. 11).

110. *Abyla trigona*, Quoy et Gaim. (**2**, pl. iv. figs. 11–17; best figure and description by Gegenbaur, **10**, Taf. xxvii., xxviii.). Mediterranean.
111. *Abyla carina*, Hkl. (Report, p. 156, Pls. XXXV., XXXVI.). Tropical Atlantic, Station 348.
112. *Abyla alata*, Hkl. (= *Abyla trigona*, Hxly., **9**, pl. iii. fig. 1). Indian and Tropical Pacific.
113. *Abyla leuckarti*, Hxly. (**9**, p. 49, pl. iii. fig. 2). South Pacific.

Genus 30. *Bassia*, Quoy et Gaim. (**3**, p. 451).

114. *Bassia tetragona*, Hkl. (Morph. Siphon.). Indian Ocean.
115. *Bassia obeliscus*, Hkl. (Report, p. 160, Pls. XXXVII., XXXVIII.). North Atlantic, Station 354.
116. *Bassia perforata*, L. Agassiz. (**36**, p. 372; = *Abyla perforata*, Ggbr., **10**, Taf. xxx. figs. 20, 21). Tropical Atlantic.
117. *Bassia quadrilatera*, Quoy et Gaim. (**3**, p. 451; = *Abyla bassensis*, Hxly., **9**, p. 45, pl. ii. fig. 1). South Pacific.

Genus 31. *Calpe*, Quoy et Gaim. (**20**, p. 11).

118. *Calpe pentagona*, Quoy et Gaim. (**20**, p. 11, pl. ii.*A*. figs. 1–7; =*Abyla pentagona*, Esch.). Accurate description and figures by Kölliker (**4**, Taf. x.); Leuckart (**5**, Taf. iii. figs. 1–10; **8**, Taf. xi. figs. 1–10); Gegenbaur (**10**, Taf. xxix.). Mediterranean.
119. *Calpe gegenbauri*, Hkl. (Report, p. 164, Pls. XXXIX., XL.). Tropical and Southern Atlantic, Stations 338, 346.
120. *Calpe huxleyi*, Hkl. (=*Abyla pentagona*, Hxly., **9**, p. 40, pl. ii. fig. 2). Tropical Pacific.

Family VIII. DESMOPHYIDÆ, Hkl. (**95**, p. 36).

Genus 32*a*. *Desmalia*, Hkl. (Report, p. 168).

121. *Desmalia imbricata*, Hkl. (Report, p. 169). Indian Ocean.

Genus 32*b*. *Desmophyes*, Hkl. (**95**, p. 36).

122. *Desmophyes annectens*, Hkl. (Report, p. 170, Pl. XXX.). Indian Ocean.

Family IX. POLYPHYIDÆ, Chun (**86**, p. 12).

Subfamily 1. HIPPOPODIDÆ, Köll. (**4**, p. 28).

Genus 33. *Hippopodius*, Quoy et Gaim. (**20**, tom. x.).

123. *Hippopodius gleba*, Leuck. (**8**, p. 299, Taf. xii. figs. 1–4). Mediterranean
124. *Hippopodius squamatus*, Hkl (Morph. Siphon.). South Atlantic (?).
125. *Hippopodius cupola*, Hkl. (Morph. Siphon.). Pacific.

Genus 34. *Polyphyes*, Hkl. (**95**, p. 36).

126. *Polyphyes elephantopus*, Hkl. (=*Hippopodius neapolitanus*, Köll., **4**, p. 28, Taf. vi. figs. 1–5; =*Elephantopus neapolitanus*, Lesson, **3**, p. 473). Mediterranean.
127. *Polyphyes ungulata*, Hkl. (Report, p. 179, Pl. XXIX. figs. 1–8). Tropical Atlantic, Station 352.

Subfamily 2. VOGTIDÆ, Hkl. (Report, pp. 177, 182).

Genus 35. *Vogtia*, Köll. (**4**, p. 31).

128. *Vogtia pentacantha*, Köll. (**4**, p. 31, Taf. viii.). Mediterranean.
129. *Vogtia spinosa*, Kef. und Ehl. (**33**, p. 24, Taf. v. figs. 16, 17). Tropical Atlantic.
130. *Vogtia köllikeri*, Hkl. (Report, p. 182, Pl. XXIX. figs. 9–14). South Atlantic, Station 326.

Order III. PHYSONECTÆ, Haeckel (**95**, p. 38).

Family X. CIRCALIDÆ, Hkl. (**95**, p. 38).

Genus 36. *Circalia*, Hkl. (**95**, p. 38).

131. *Circalia stephanoma*, Hkl. (Report, p. 198, Pl. XXI. figs. 1–4). North Atlantic.
132. *Circalia haplorhiza*, Hkl. (= *Physophora alba*, Quoy et Gaim., **2**, pl. i. figs. 1–9; = *Haplorhiza alba*, L. Agassiz, **36**, p. 368). South Atlantic.
133. *Circalia papillosa*, Hkl. (= *Agalma papillosum*, Fewk., **44**, pl. v. figs. 5, 6). Tropical Atlantic (?).

Family XI. ATHORIDÆ, Hkl. (**95**, p. 38).

Genus 37. *Athoria*, Hkl. (**95**, p. 39).

134. *Athoria larvalis*, Hkl. (Report, p. 202, Pl. XXI. figs. 5–8). Indian Ocean.
135. *Athoria bractealis*, Hkl. (Report, p. 201). South Pacific, Station 288 (?).

Genus 38. *Athoralia*, Hkl. (**95**, p. 39).

136. *Athoralia coronula*, Hkl. (Morph. Siphon.). Indian Ocean.

Family XII. APOLEMIDÆ, Hxly. (**9**, p. 70).

Genus 39. *Dicymba*, Hkl. (**95**, p. 39).

137. *Dicymba diphyopsis*, Hkl. (Report, p. 210, Pl. XVIII. figs. 1–7). Indian Ocean.

Genus 40*a*. *Apolemia*, Esch. (**1**, p. 143).

138. *Apolemia uvaria*, Esch. (**4**, Taf. vi. figs. 6–9; **7**, p. 319, Taf. xviii. figs. 1–4; **8**, Taf. xii. figs. 8–11, &c.). Mediterranean.

Genus 40*b*. *Apolemopsis*, Brandt (**25**, p. 36).

139. *Apolemopsis uviformis*, Hkl. (= *Stephanomia uviformis*, Lesueur, in an unpublished plate, and **15**; = *Apolemia lesueuria*, Lesson, **3**, p. 518). North Atlantic.
140. *Apolemopsis dubia*, Brdt. (**25**, p. 36). Tropical Pacific.

Family XIII. AGALMIDÆ, Brandt (**25**, p. 34).

Subfamily 1. CRYSTALLODINÆ, Hkl. (**95**, p. 39).

Genus 41. *Stephanomia*, Péron et Lesueur (**14**).

141. *Stephanomia amphitrites*, Péron et Lesueur (**14**, pl. xxix. fig. 5; **9**, p. 72, pl. vi.). Tropical Pacific.
142. *Stephanomia nereidum*, Hkl. (Morph. Siphon.). Indian Ocean.

Genus 42. *Crystallodes*, Hkl. (**84**, p. 43).

143. *Crystallodes rigida*, Hkl. (**84**, p. 43, Taf. vi.–xiii.). North Atlantic.
144. *Crystallodes vitrea*, Hkl. (Report, p. 222, Pl. XVII.). Indian Ocean.
145. *Crystallodes mertensii*, Hkl. (= *Agalma mertensii*, Brandt, **25**, p. 34, figured by Mertens). North Pacific.
146. *Crystallodes plethosoma*, Hkl. (= *Plethosoma crystalloides*, Less., **22**, pl. iv. fig. 2). Tropical Pacific.

Genus 43. *Phyllophysa*, L. Agassiz (**36**, p. 369).

147. *Phyllophysa squamacea*, Hkl. (Morph. Siphon.). (= *Stephanomia amphitrites*, Hxly., **9**, pl. vi.). South Pacific (?).
148. *Phyllophysa foliacea*, L. Agassiz (= *Stephanomia foliacea*, Quoy et Gaim., **2**, pl. iii. figs. 8–12). Tropical Pacific (?).

Genus 44. *Agalma*, Esch. (**21**, p. 743; **1**, p. 150).

149. *Agalma okenii*, Esch. (**1**, Taf. xiii. fig. 1; **21**, Taf. v. fig. 17). North Pacific.
150. *Agalma breve*, Hxly. (**9**, p. 75, pl. vii.). South Pacific.
151. *Agalma eschscholtzii*, Hkl. (Report, p. 226, Pl. XVIII. figs. 8–17). Indian Ocean.
152. *Agalma polygonata*, Hkl. (= *Crystallomia polygonata*, Dana, **73**, p. 459). North Pacific (?).
153. *Agalma clavata*, Leuck. (**8**, Taf. xiii. figs. 1–6). Mediterranean.

Subfamily 2. ANTHEMODINÆ, Hkl. (**95**, p. 40).

Genus 45. *Anthemodes*, Hkl. (**38**, p. 36).

154. *Anthemodes ordinata*, Hkl. (Report, p. 229, Pls. XIV., XV.). North Atlantic.
155. *Anthemodes articulata*, Hkl. (Morph. Siphon.). South Atlantic, Station 325.

Genus 46. *Cuneolaria*, Eysenhardt (**16**, p. 369).

156. *Cuneolaria incisa*, Eysenhardt (**16**, p. 369, pl. xxxiii. fig. 5). North Pacific (?).
157. *Cuneolaria imbricata*, L. Agassiz (= *Stephanomia imbricata*, Quoy et Gaim., **2**, pl. iii. figs. 13–15). South Pacific (?).

Genus 47. *Halistemma*, Hxly. (**9**, p. 129).

158. *Halistemma rubrum*, Hxly. (= *Agalma rubra*, Vogt, **6**, pls. vii.–xi.). Mediterranean.
159. *Halistemma punctatum*, L. Agassiz (**36**, p. 369; = *Agalmopsis punctata*, Köll., **4**, Taf. iv.). South Mediterranean (?).

Genus 48*a*. *Cupulita*, Quoy et Gaim. (**19**, p. 580).

160. *Cupulita bowdichii*, Quoy et Gaim. (**19**, pl. lxxxvii. figs. 14–16). South Pacific (?).
161. *Cupulita sarsii*, Hkl. (= *Agalmopsis elegans*, Sars, *partim*, **27**, Heft i. Taf. v., not vi.). North Atlantic.
162. *Cupulita canariensis*, Hkl. (= *Anthemodes canariensis*, Hkl., **38**, p. 36, Taf. i.). North-east Atlantic.
163. *Cupulita cara*, Hkl. (= *Nanomia cara*, A. Agassiz, **37**, p. 200). North-west Atlantic.
164. *Cupulita fragilis*, Hkl. (= *Agalmopsis fragilis*, Fewk., **44**, pl. v. fig. 2, pl. vi.). Tropical Atlantic.
165. *Cupulita picta*, Hkl. (= *Halistemma pictum*, Metschn., 1871, in an inaccessible Russian paper, Tab. ii.). Mediterranean.
166. *Cupulita tergestina*, Hkl. (= *Halistemma tergestinum*, Claus, **74**, Taf. i.–v.). Adriatic.

Genus 48*b*. *Agalmopsis*, Sars (**27**, Heft i. p. 32).

167. *Agalmopsis elegans*, Sars, *partim* (**27**, Heft i. Taf. vi., not v.). North Atlantic.
168. *Agalmopsis catena*, Hkl. (= *Agalma elegans*, Fewk., **43**, p. 163, pls. ix., x.). Ontogeny, **89**, p. 239, pls. i.–iv. Tropical Atlantic.
169. *Agalmopsis dissoluta*, Hkl. (Morph. Siphon.). South Atlantic.
170. *Agalmopsis sarsii*, Köll. (**4**, p. 10, Taf. iii.). Mediterranean.

Genus 49. *Lychnagalma*, Hkl. (**95**, p. 40).

171. *Lychnagalma vesicularia*, Hkl. (Report, p. 235, Pl. XVI.). Indian Ocean.
172. *Lychnagalma utricularia*, Hkl. (= *Agalmopsis utricularia*, Claus, **75**; = *Calliagalma utricularia*, Fewk., **42**, vol. xvii. p. 844). Mediterranean.

Family XIV. FORSKALIDÆ, Hkl. (**95**, p. 42),

Genus 50. *Strobalia*, Hkl. (**95**, p. 42).

173. *Strobalia cupola*, Hkl. (Morph. Siphon.). Indian Ocean.
174. *Strobalia conifera*, Hkl. (Report, p. 243). South Pacific, Station 288.

Genus 51. *Forskalia*, Köll. (**4**, p. 2).

175. *Forskalia contorta*, Leuck. (= *Stephanomia*, Milne-Edwards, **71**, pls. vii.–x.). Mediterranean.
176. *Forskalia edwardsii*, Köll. (**4**, p. 2, Taf. i., ii.). Mediterranean.
177. *Forskalia tholoides*, Hkl. (Report, p. 244, Pls. VIII.–X.). North Atlantic.
178. *Forskalia atlantica*, Hkl. (= *Stephanomia atlantica*, Fewk., **44**, pl. v. fig. 1). Tropical Atlantic.

Genus 52. *Forskaliopsis*, Hkl. (Report, p. 247).

179. *Forskaliopsis ophiura*, Hkl. (= *Forskalia ophiura*, Leuck., **8**, p. 351, Taf. xiii. figs. 18–21). Mediterranean.
180. *Forskaliopsis magnifica*, Hkl. (Report, p. 248). Indian Ocean.

Genus 53. *Bathyphysa*, Studer (**40**, p. 21).

181. *Bathyphysa abyssorum*, Studer (**40**, p. 21, Taf. iii.). North Atlantic.
182. *Bathyphysa grandis*, Hkl. (= *Pterophysa grandis*, Fewk., **45**, p. 969). North Atlantic (?).
183. *Bathyphysa gigantea*, Hkl. (Morph. Siphon.). South Atlantic, Station 323 (?).

Family XV. NECTALIDÆ, Hkl. (**95**, p. 41).

Genus. 54*a*. *Nectalia*, Hkl. (**95**, p. 41).

184. *Nectalia loligo*, Hkl. (Report, p. 252, Pl. XIII.). North Atlantic.

Genus 54*b*. *Sphyrophysa*, L. Agassiz (**36**, p. 368).

185. *Sphyrophysa intermedia*, L. Agassiz (= *Physophora intermedia*, Quoy et Gaim., **2**, pl. i. figs. 10–18). Tropical Atlantic (?).

Family XVI. DISCOLABIDÆ, Hkl. (**95**, p. 41).

Genus 55. *Physophora*, Forskål (**11**, p. 119).

186. *Physophora hydrostatica*, Forskål (**11**, p. 119; Claus, **34**, Taf. xxv.–xxvii.). North Mediterranean.
187. *Physophora philippii*, Köll. (**4**, p. 19, Taf. v.). South Mediterranean.
188. *Physophora magnifica*, Hkl. (**84**, p. 36, Taf. i.–v.). North Atlantic.

189. *Physophora borealis*, Sars (**27**, Heft iii. Taf. v., vi.). North Atlantic.
190. *Physophora disticha*, Lesson (**22**, pl. xvi. fig. 3). Tropical Pacific (?).
191. *Physophora myzonema*, Péron et Les. (**14**, pl. xxix. fig. 4). Tropical Atlantic (?).

Genus 56. *Discolabe*, Esch. (**1**, p. 155).

192. *Discolabe mediterranea*, Esch. (= *Physophora tetrasticha*, Phil., **72**, Taf. v.). Mediterranean.
193. *Discolabe tetrasticha*, Hkl. (Morph. Siphon.). North Atlantic (?).
194. *Discolabe quadrigata*, Hkl. (Report, p. 263, Pls. XIX., XX.). Indian Ocean.

Genus 57. *Stephanospira*, Ggbr. (**10**, p. 67).

195. *Stephanospira insignis*, Ggbr. (**10**, p. 67, figs. 53–56). Tropical Atlantic (?).
196. *Stephanospira corona*, Hkl. (Morph. Siphon.). North Atlantic.

Family XVII. ANTHOPHYSIDÆ, Brandt (**25**, p. 35).
(*Athorybidæ*, Huxley, **9**, pp. 71, 85).

Genus 58. *Rhodophysa*, Blainv. (**24**, p. 123).

197. *Rhodophysa corona*, Hkl. (Report, p. 274). Indian Ocean.

Genus 59. *Melophysa*, Hkl. (**95**, p. 42).

198. *Melophysa melo*, Hkl. (= *Athorybia melo*?, Quoy, **2**, pl. ii. figs. 7–12). Mediterranean (?).

Genus 60. *Athorybia*, Esch. (**1**, p. 153).

199. *Athorybia rosacea*, Esch. (**4**, p. 24, Taf. vii.). Mediterranean.
200. *Athorybia heliantha*, Ggbr. (**10**, Taf. xxxi. figs. 43, 44). North Atlantic.
201. *Athorybia ocellata*, Hkl. (Report, p. 276, Pls. XI., XII. figs. 10–18). North Atlantic.
202. *Athorybia indica*, Hkl. (= *Athorybia rosacea*, Hxly., **9**, p. 86, pl. ix.). Indian Ocean.

Genus 61. *Anthophysa*, Mertens (**25**, p. 35).

203. *Anthophysa rosea*, Mertens (**25**, p. 35). North Pacific.
204. *Anthophysa formosa*, Hkl. (= *Athorybia formosa*, Fewk., **44**, pl. v. figs. 3, 4). North Atlantic.
205. *Anthophysa darwinii*, Hkl. (Report, p. 278, Pl. XII. figs. 7–9). South Atlantic, Station 334.

Order IV. AURONECTÆ, Haeckel (**95**, p. 43).

Family XVIII. STEPHALIDÆ, Hkl. (**95**, p. 43).

Genus 62*a*. *Stephalia*, Hkl. (**95**, p. 43).

206. *Stephalia corona*, Hkl. (Report, p. 297, Pl. VII.). North Atlantic ("Triton" Expedition).

Genus 62*b*. *Stephonalia*, Hkl. (Report, p. 299).

207. *Stephonalia bathyphysa*, Hkl. (Report, p. 299, Pl. VI.). South Pacific, Station 166.

Family XIX. RHODALIDÆ, Hkl. (**95**, p. 43).

Genus 63. *Auralia*, Hkl. (**95**, p. 43).

208. *Auralia profunda*, Hkl. (Report, p. 301). Tropical Atlantic.
209. *Auralia globosa*, Hkl. (=*Angelopsis globosa*, Fewk., **45**, p. 972, pl. x. figs. 4, 5). Tropical Atlantic (?).

Genus 64. *Rhodalia*, Hkl. (**95**, p. 43).

210. *Rhodalia miranda*, Hkl. (Report, p. 302, Pls. I.–V.). South Atlantic, Station 320.

Order V. CYSTONECTÆ, Haeckel (**95**, p. 44).

Family XX. CYSTALIDÆ, Hkl. (**95**, p. 44).

Genus 65. *Cystalia*, Hkl. (**95**, p. 44).

211. *Cystalia monogastrica*, Hkl. (Report, p. 316, Pl. XXII. figs. 1–5). Indian Ocean; South Pacific, Station 288.
212. *Cystalia challengeri*, Hkl. (Report, p. 314). South Pacific, Station 288 (?).

Family XXI. RHIZOPHYSIDÆ, Bdt. (**25**, p. 33).

Subfamily 1. CANNOPHYSIDÆ, Hkl. (**95**, p. 44).

Genus 66. *Aurophysa*, Hkl. (**95**, p. 44).

213. *Aurophysa ordinata*, Hkl. (Morph. Siphon.). Indian Ocean.
214. *Aurophysa inermis*, Hkl. (=*Rhizophysa inermis*, Studer, **40**, p. 13, Taf. i. figs. 3, 8, 9, 10). Indian Ocean.

Genus 67. *Cannophysa*, Hkl. (**95**, p. 44).

215. *Cannophysa murrayana*, Hkl. (Report, p. 324, Pl. XXIV.). North Atlantic.
216. *Cannophysa gracilis*, Hkl. (= *Rhizophysa gracilis*, Fewk., **44**, p. 269, pl. vi. figs. 1–6). Tropical Atlantic.

Subfamily 2. LINOPHYSIDÆ, Hkl. (**95**, p. 45).

Genus 68. *Linophysa*, Hkl. (**95**, p. 45).

217. *Linophysa conifera*, Hkl. (= *Rhizophysa conifera*, Studer, **40**, p. 4, Taf. i.). Tropical Atlantic.

Genus 69. *Nectophysa*, Hkl. (**95**, p. 45).

218. *Nectophysa wyvillei*, Hkl. (Report, p. 327, Pl. XXIII.). North Atlantic.
219. *Nectophysa eysenhardtii*, Hkl. (= *Rhizophysa eysenhardtii*, Ggbr., **10**, p. 78, Tab. xxxi. figs. 46–49). North Atlantic.

Genus 70. *Pneumophysa*, Hkl. (**95**, p. 45).

220. *Pneumophysa gegenbauri*, Hkl. (Morph. Siphon.). Indian Ocean.

Genus 71. *Rhizophysa*, Péron et Lesueur (**14**).

221. *Rhizophysa filiformis*, Lamk. (= *Physophora filiformis*, Forsk.; Ggbr., **7**, p. 324, Taf. xviii. figs. 5–11). Mediterranean.
222. *Rhizophysa planostoma*, Péron (**14**, pl. xxix. fig. 3). Tropical Atlantic.
223. *Rhizophysa mertensii*, Lesson (**3**, p. 492; = *Epibulia mertensii*, Brdt., **25**, p. 33). North Pacific.

Family XXII. SALACIDÆ, Hkl. (**95**, p. 45).

Genus 72. *Salacia*, Hkl. (**95**, p. 45).

224. *Salacia polygastrica*, Hkl. (Report, p. 331, Pl. XXV.). Tropical Atlantic, Station 338.
225. *Salacia uvaria*, Hkl. (= *Rhizophysa uvaria*, Fewk., **45**, p. 967, pl. x. fig. 6). North Atlantic.

Family XXIII. EPIBULIDÆ, Hkl. (Report, p. 332).

Genus 73*a*. *Epibulia*, Eschscholtz (**1**, p. 148; = *Arethusa*, Hkl., **95**, p. 46).

226. *Epibulia ritteriana*, Hkl. (Report, p. 335, Pl. XXII. figs. 6–8). Indian Ocean.
227. *Epibulia chamissonis*, Esch. (= *Rhizophysa chamissonis*, Eysenhardt, **77**, Tab. xxxv. fig. 3). North Pacific.
228. *Epibulia erythrophysa*, Brdt. (**25**, p. 34), figured by Mertens. Tropical Pacific.

Genus 73*b*. *Angela*, Lesson (**3**, p. 496).

229. *Angela cytherea*, Less. (**3**, p. 496, pl. ix. fig. 1). Tropical Atlantic (?).

Family XXIV. PHYSALIDÆ, Brdt. (**25**, p. 36).

Subfamily 1. ARETHUSIDÆ, Hkl. (Report, p. 347).

Genus 74*a*. *Alophota*, Brdt. (**25**, p. 37).

230. *Alophota giltschiana*, Hkl. (Report, p. 348, Pl. XXVI. figs. 1–3). North Atlantic.
231. *Alophota olfersii*, Brdt. (**25**, p. 37). Tropical Atlantic.
232. *Alophota mertensii*, Hkl. (Morph. Siphon.). Indian Ocean.

Genus 74*b*. *Arethusa*, Hkl. (Report, p. 349).

233. *Arethusa challengeri*, Hkl. (Report, p. 349, Pl. XXVI. figs. 4–8). North Atlantic, Station 354.
234. *Arethusa thalia*, Hkl. (Morph. Siphon.). Indian Ocean (?).

Subfamily 2. CARAVELLIDÆ, Hkl. (Report, p. 347).

Genus 75*a*. *Physalia*, Lamk. (**90**, tom. ii. p. 480).

235. *Physalia pelagica*, Bosc (Eyshdt., **77**, p. 45, Tab. xxxv. fig. 2). South Atlantic.
236. *Physalia cornuta*, Til. (**76**, p. 42, Tab. i. figs. 15, 16). Indian Ocean (?).
237. *Physalia utriculus*, Esch. (**1**, p. 163, Taf. xiv. figs. 2, 3). Tropical and Subtropical Pacific.
238. *Physalia megalista*, Lamk. (Péron, **14**, pl. xxix. fig. 1), Mertens (?). South Atlantic and Indian Ocean.

Genus 75*b*. *Caravella*, Hkl. (Report, p. 351).

239. *Caravella gigantea*, Hkl. (=*Physalia cystisoma*, Lesson, *partim*; =*Physalia gigantea*, Bory; Postels et Mertens, Icon.). Tropical and Southern Atlantic.
240. *Caravella maxima*, Hkl. (=*Physalia caravella*, Esch., **1**, Taf. xiv. fig. 1; =*Physalia arethusa*, Olfers, **79**, Taf. i., ii.; L. Agassiz, **36**, pl. xxxv.). Tropical and Northern Atlantic.

GLOSSARY.

N.B.—The signification of the characters is the same in all the Plates.

	Latin Scientific Term.	English Term.	German Term.
a	*Truncus* (*Cœnosarc*).	*Common stem.*	*Stamm.*
aa	Apex trunci.	Top of the stem.	Scheitelpunkt.
ab	Cormidia.	Groups of persons.	Personen-Gruppen.
ac	Canales trunci.	Vessels of the trunk.	Stamm-Canäle.
ad	Linea dorsalis trunci.	Dorsal line of the stem.	Stamm-Rückenlinie.
af	Facetta (insertio cormidii).	Insertion of the cormidia.	Cormidien-Facetten.
ah	Antrum hypocystale.	Hypocystic cavity.	Blasengrund-Höhle.
ai	Internodia trunci.	Internodes of the trunk.	Stamm-Zwischenknoten.
am	Nodi trunci.	Nodes of the trunk.	Stamm-Knoten.
an	Nectosoma (truncus motorius).	Swimming body.	Schwimmkörper.
ao	Ostium terminale (prostoma).	Primitive mouth.	Urmund.
ap	Sipho primordialis (truncus).	Primitive siphon.	Ursipho.
as	Siphosoma (truncus nutritivus).	Nutritive body.	Nährkörper.
at	Tubus trunci centralis.	Axial tube of the stem.	Axenrohr.
av	Linea ventralis trunci.	Ventral line of the stem.	Stamm-Bauchlinie.
az	Fulcrum trunci.	Supporting plate of the stem.	Stamm-Stützplatte.
b	*Bracteæ* (*Hydrophyllia*).	*Protectives.*	*Deckstücke.*
ba	Facies exumbralis bracteæ.	Exumbrellar face of the bract.	Deckstück-Mantel.
bb	Basis bracteæ.	Base of the bract.	Deckstück-Basis.
bc	Phyllocystis.	Phyllocyst.	Deckstück-Blase.
bd	Margo dorsalis.	Dorsal edge of the bract.	Rücken-Kante.
bh	Cavitus bractealis.	Subumbrellar cavity of the bract.	Deckstück-Höhle.
bk	Cnidotæniæ.	Urticating bands.	Nesselrippen.
bl	Margo sinister.	Left-hand edge.	Linke Kante.
bp	Pedunculus bracteæ.	Pedicle of the bract.	Deckstück-Stiel.
bv	Margo ventralis.	Ventral edge of the bract.	Bauch-Kante.
bx	Margo dexter.	Right-hand edge.	Rechte Kante.
c	*Canales* (*vasa nutritiva*).	*Vessels.*	*Canäle.*
ca	Canalis axialis.	Axial vessel.	Axen-Canal.
cb	Canalis bractealis.	Canal of the bract.	Deckstück-Canal.

	Latin Scientific Term.	English Term.	German Term.
cc	Canalis circularis.	Annular marginal vessel.	Ring-Canal (am Schirmrande).
cd	Canalis dorsalis.	Dorsal radial vessel.	Rücken-Canal.
ce	Canales palliales.	Mantle-vessels.	Mantel-Canäle.
cf	Canalis ovarii.	Ovarial vessel.	Eierstocks-Canal.
cg	Canalis gonophoræ.	Gonophoral vessel.	Sexual-Canal.
ch	Canalis spermarii.	Testicular vessel.	Hoden-Canal.
ci	Canalis gemmalis.	Bud vessel.	Knospen-Canal.
ck	Canales centradeniæ.	Vessels of the central gland.	Canäle der Centraldrüse.
cl	Canalis sinister.	Left-hand radial vessel.	Linker Radial-Canal.
cm	Canales hepatici.	Liver-vessels.	Leber-Canäle.
cn	Canalis nectophoræ.	Nectocalycine duct.	Schwimmglocken-Canal.
co	Canalis oleophorus.	Oleocyst.	Ölblase.
cp	Canalis pedunculi.	Pedicular vessel.	Stiel-Canal.
cq	Canalis palponis.	Hydrocystic vessel.	Taster-Canal.
cr	Canales radiales.	Radial vessels.	Radial Canäle.
cs	Canalis somatocystis.	Acrocyst or somatocyst.	Saftbehälter.
ct	Canalis tentaculi.	Tentacular vessel.	Tentakel-Canal.
cu	Canales umbrellæ.	Vessels of the umbrella.	Schirm-Canäle.
cv	Canalis ventralis.	Ventral radial vessel.	Bauch-Canal.
cw	Canales renales.	Kidney-vessels.	Nieren-Canäle.
cx	Canalis dexter.	Right-hand radial vessel.	Rechter Radial-Canal.
cy	Canales spadicini.	Spadicine vessels.	Spadicin-Canäle.
cz	Canalis coronalis (in sulco coronali Disconectarum).	Coronal vessel of the subumbrella.	Kranz-Canal.
d	*Entoderma.*	*Entoderm.*	*Darmblatt.*
e	*Exoderma.*	*Exoderm.*	*Hautblatt.*
f	*Gynophoræ (Gonophoræ femininæ).*	*Female Medusæ.*	*Weibchen.*
fc	Canalis centralis gynophoræ.	Canal of the ovisac.	Eierstocks-Canal.
fm	Ovarium (manubrium medusæ).	Ovisac.	Eierstock.
fo	Acini ovulorum.	Egg-clusters.	Eier-Trauben.
fp	Pedunculus gynophoræ.	Pedicle of the gynophore.	Weibchen-Stiel.
fu	Umbrella gynophoræ.	Gynocalyx.	Eierstocks-Schirm.
fx	Spadix feminina.	Gynospadix.	Eierstocks-Spadix.
g	*Gonophoræ (Medusæ Sexuales).*	*Sexual Medusæ.*	*Geschlechts-Personen.*
ga	Gonodendron (gonocormus).	Sexual cluster.	Geschlechts-Traube.
gb	Cormidia sexualia.	Branches of the sexual cluster.	Geschlechts-Trauben-Aeste.
gc	Canalis centralis gonophoræ.	Central canal of the gonophore.	Canal der Geschlechts-Person.
gf	Gonodendron femininum.	Female cluster.	Weibliche Traube.
gh	Gonodendron masculinum.	Male cluster.	Männliche Traube.
gk	Cnidonodes of the gonophores.	Urticating nodes of the sexual Medusæ.	Nesselknoten der Geschlechts-Personen.
gm	Manubrium (gonades).	Gonosac.	Geschlechts-Drüse.
gp	Pedunculus gonophoræ.	Pedicle of the gonophore.	Stiel der Geschlecht-Person.
gq	Gonopalpon (palpo sexualis).	Sexual taster.	Geschlechts-Taster.
gs	Gonostylus (truncus gonodendri).	Stem of the sexual cluster.	Stamm der Geschlechts-Traube.

	Latin Scientific Term.	English Term.	German Term.
gu	Gonumbrella.	Umbrella of the gonophore.	Schirm der Geschlechts-Person
gx	Spadix.	Axial tube of the manubrium.	Entoderm-Rohr der Geschlechts-Drüse.
h	*Androphoræ* (*Gonophoræ masculinæ*).	*Male Medusæ.*	*Männchen.*
hc	Canalis centralis androphoræ.	Canal of the sperm-sac.	Hoden-Canal.
hm	Spermarium (manubrium Medusæ masculinæ).	Sperm-sac.	Hoden.
hp	Pedunculus androphoræ.	Pedicle of the androphore.	Männchen-Stiel.
hs	Sperma.	Sperm.	Samen.
hu	Umbrella androphoræ.	Androcalyx.	Hoden-Schirm.
hx	Spadix masculina.	Androspadix.	Hoden-Spadix.
i	*Gemmæ.*	*Buds.*	*Knospen.*
ib	Gemma bracteæ.	Bud of bract.	Deckstück-Knospe.
ig	Gemma gonophoræ.	Bud of gonophore.	Geschlechts-Knospe.
in	Gemma nectophoræ.	Bud of nectocalyx.	Schwimmglocken-Knospe.
iq	Gemma palponis.	Bud of taster.	Taster-Knospe.
is	Gemma siphonis.	Bud of polypite.	Sipho-Knospe.
it	Gemma tentaculi.	Bud of tentacle.	Tentakel-Knospe.
k	*Cnidia* (*Nematillæ*).	*Urticating organs.*	*Nessel organe.*
kb	Cnidoblasti.	Thread-cells.	Nessel-Zellen.
kc	Cnidocystæ (capsulæ urticantes).	Thread-cysts.	Nessel-Kapseln.
kg	Cnidoblasti grandes.	Large thread-cells.	Grosse Nessel-Zellen.
kl	Cnidoblasti laterales.	Lateral thread-cells.	Seitliche Nessel-Zellen.
km	Cnidoblasti mediales.	Median thread-cells.	Mittlere Nessel-Zellen.
kn	Cnidonodi.	Urticating nodes.	Nessel-Knoten.
kp	Cnidoblasti pyriformes.	Pyriform thread-cells.	Birnförmige Nessel-Zellen.
ks	Cnidosacci.	Urticating sacculi.	Nessel-Säckchen.
kt	Cnidotænia.	Urticating band.	Nessel-Band.
l	*Aurophora* (*Campana pneumatica*).	*Air-bell* (of the Auronectæ).	*Luftglocke.*
la	Auroductus (canalis axialis).	Auroduct.	Luftgang.
lb	Basis aurophoræ.	Base of the aurophore.	Luftglocken-Grund.
lc	Canal circularis aurophoræ.	Ring-canal of the aurophore.	Ring canal der Luftglocke.
le	Epithelium auroductus.	Epithelium of the auroduct.	Luftgang-Epithel.
lf	Vagina pistilli (cuticularis).	Sheath of the pistil.	Scheide des Luftstempels.
li	Auropyle (ostium internum).	Aperture of the auroduct.	Luftglocken-Pforte.
lm	Musculus pistilli.	Muscle of the pistil.	Stempel-Muskel.
ln	Nuclei musculorum.	Nuclei of the muscles.	Muskel-Kerne.
lo	Aurostigma (ostium externum).	Mouth of the auroduct.	Luftglocken-Mündung.
lp	Pistillum.	Pistil of the aurophore.	Luftglocken-Stempel.
lr	Bursæ radiales aurophoræ.	Radial pouches of the aurophore.	Radial-Taschen der Luftglocke.
ls	Septa radialia.	Radial septa (between them).	Radial-Septen.
lz	Fulcrum aurophoræ.	Supporting plate.	Stützplatte der Luftglocke.
m	*Musculi.*	*Muscles.*	*Muskeln.*

	Latin Scientific Term.	English Term.	German Term.
n	*Nectophoræ (nectocalyces).*	*Swimming-bells.*	*Schwimmglocken.*
na	Apex nectophoræ.	Top of the swimming-bell.	Schwimmglocken-Scheitel.
nb	Basis pedunculi (insertio).	Basal insertion of the bell-pedicle.	Insertions-Basis.
nc	Canalis circularis nectophoræ.	Marginal ring-canal.	Ring-canal (der Glocken-Mündung).
nd	Ala dorsalis nectophoræ.	Dorsal wing of the bell.	Rückenflügel der Schwimmglocke.
ne	Canales accessorii pedunculi.	Accessory pedicular canals.	Stiel canal-Aeste.
nf	Fissura infundibuli.	Hydrœcial cleft.	Gehäuse-Spalte.
ng	Margo basalis nectophoræ.	Edge of the bell-base.	Basal-Kante.
nh	Cavitas nectophoræ.	Bell cavity.	Schwimmglocken-Höhle.
ni	Infundibulum (hydrœcium).	Hydrœcial cavity.	Gehäuse des Stammes.
nk	Margo coryphalis (crista sagittalis).	Sagittal crest of the nectocalyx.	Scheitel-Kante der Schwimmglocke.
nl	Ala sinistra nectophoræ.	Left wing of the swimming-bell.	Linker Flügel der Schwimmglocke.
nm	Musculi pedunculi.	Muscles of the pedicle.	Stiel muskel.
nn	Nectophora specialis (Calyconectæ).	Special nectophore.	Special-Schwimmglocke.
no	Ostium nectophoræ.	Mouth of the nectosac.	Schwimmhöhlen-Mündung.
np	Pedunculus nectophoræ.	Pedicle of the nectophore.	Schwimmglocken-Stiel.
nq	Condylus articularis nectophoræ (Abylidæ).	Articular apophysis of the nectocalyx.	Gelenk-Kopf der Schwimmglocke.
nr	Canales radiales nectophoræ.	Radial canals of the bell.	Radial-Canäle der Schwimmglocke.
ns	Canalis pedunculares.	Pedicular canal.	Stiel-Canal.
nt	Septum frontale nectophoræ.	Septum between nectosac and hydrœcium.	Frontal-Septum der Schwimmglocke.
nu	Gelatina nectophoræ.	Jelly of the swimming-bell.	Schirm-Gallerte.
nv	Ala ventralis nectophoræ.	Ventral wing of the bell.	Bauchflügel der Schwimmglocke.
nw	Nectosaccus.	Swimming-sac.	Schwimmsack.
nx	Ala dextra nectophoræ.	Right wing of the swimming-bell.	Rechter Flügel der Schwimmglocke.
nz	Ala dentata nectophoræ.	Toothed wing of the bell.	Zahnflügel der Schwimmglocke.
o	*Ovula.*	*Eggs.*	*Eier.*
o^1	Macula germinativa.	Nucleolus of the egg.	Keimfleck.
o^2	Vesicula germinativa.	Nucleus of the egg.	Keimbläschen.
o^3	Lecythus germinativus.	Protoplasm of the egg.	Keimdotter.
p	*Pneumatophora.*	*Swimming-Bladder.*	*Schwimmblase.*
pa	Antrum pneumaticum.	Air-cavity.	Lufthöhle.
pb	Basis (pedunculus) pneumatophoræ.	Basal pedicle of the float.	Schwimmblasen-Stiel.
pc	Cavitas pericystalis.	Pericystic cavity of the float.	Pericyst-Höhle der Schwimmblase.
pd	Pneumadenia (glandula pneumatica).	Air-secreting gland.	Luftdrüse.
pe	Stigmata (pori exumbrales).	Pneumatic pores (Disconectæ).	Luftporen der Exumbrella.
pf	Pneumatocysta (lagena pneumatica).	Air-flask.	Luftflasche.
pg	Pneumothyræ (pori communicantes annulorum).	Apertures of the ring-chambers (Disconectæ).	Communications-Thüren der Luft-Ring-Kammern.
ph	Camera centralis pneumatocystæ.	Central chamber of the float.	Central kammer der Luftflasche.

	Latin Scientific Term.	English Term.	German Term.
pi	Infundibulum (pneumatochone).	Air-funnel of the float.	Lufttrichter der Schwimmblase.
pk	Cameræ concentricæ pneumatocystæ.	Ring-chambers of the float (Disconectæ).	Ring-Kammern der Luftflasche.
pl	Foveola auropylæ.	Basal dimple of the air-bell.	Basal-Grübchen der Luftflasche.
pm	Musculi longitudinales.	Radial muscles of the float.	Längs-Muskeln der Schwimmblase.
pn	Musculi transversi.	Circular muscles of the float.	Ring-Muskeln der Schwimmblase.
po	Ostium apicale (stigma centrale).	Top-opening of the float.	Scheitel-Öffnung der Schwimmblase.
pp	Pigmentum apicale (mitra ocellaris).	Pigment-cap of the float.	Farben-Kappe des Luftsacks.
pq	Bursæ radiales pneumatophoræ.	Radial pouches of the float.	Radial-Taschen der Pericyst-Höhle.
pr	Septa radialia.	Radial septa (between them).	Radial-septen.
ps	Pneumatosaccus.	Air-sac.	Luftsack.
pt	Tracheæ.	Air-tubules (Disconectæ).	Luftröhren.
pu	Pneumatocodon (umbrella pneumatica).	Pneumatic umbrella.	Luftschirm.
pv	Villi hypocystales.	Funnel-villi (Cystonectæ).	Trichter-Zotten des Luftsacks.
pw	Tapetum endocystale.	Secondary exoderm of the float.	Luftflaschen-Tapete.
px	Apex pneumatophoræ.	Top of the float.	Schwimmblasen-Spitze.
py	Pylorus infundibuli.	Funnel-gate of the float.	Trichter-Pforte der Luftflasche.
pz	Fulcrum (lamina fulcralis).	Supporting plate of the float.	Stützplatte der Schwimmblase.
q	*Palpones (Hydrocystæ).*	*Tasters (Feelers).*	*Taster.*
qa	Apex palponis.	Top of the taster.	Taster-Spitze.
qb	Basis palponis.	Base of the taster.	Taster-Basis.
qc	Cavum palponis.	Cavity of the taster.	Taster-Höhle.
qo	Ocellus palponis.	Eye of the taster.	Taster-Auge.
qp	Pedunculus palponis.	Pedicle of the taster.	Taster-Stiel.
r	*Palpacula.*	*Feeling filaments.*	*Fühlfäden.*
s	*Siphones (Polypites).*	*Suctorial-tubes.*	*Saugröhren.*
sa	Sipho centralis (Disconectarum).	Central polypite.	Central-Sipho.
sb	Basigaster.	Basal chamber of the polypite.	Grundmagen.
sc	Cavum siphonale.	Cavity of the polypite.	Sipho-Höhle.
sf	Fissuræ gastrales.	Openings of the radial canals.	Gastral-Ostien.
sg	Bursæ gastrales.	Pouches of the stomach.	Magentaschen.
sh	Striæ hepaticæ.	Liver-ridges.	Leber-Streifen.
si	Aster hepaticus (Disconectarum).	Liver-star.	Leber-Canal-Stern.
sk	Valvula pylorica.	Pyloric valve.	Pylorus-Klappe.
sl	Labia oralia.	Lips of the mouth.	Mund-Lippen.
sm	Stomachus.	Stomach.	Magen.
sn	Siphones secundarii.	Metasiphons.	Neben-Siphonen.
so	Osculum.	Mouth.	Mund.
sp	Pedunculus siphonalis.	Pedicle of the polypite.	Sipho-Stiel.
sr	Proboscis.	Pharynx.	Rüssel.
ss	Discus suctorius.	Suctorial disc of the mouth.	Saugscheibe.
st	Tabula gastrobasalis (Disconectarum).	Gastrobasal plate (between centradenia and central siphon).	Magengrund-Platte.

	Latin Scientific Term.	English Term.	German Term.
su	Sipho primarius (protosiphon).	Protosiphon.	Ursipho.
sv	Villi hepatici stomachi.	Hepatic villi.	Leber-Zotten.
sw	Plicæ internæ stomachi.	Stomach-folds.	Magen-Falten.
sx	Siphones sexuales.	Sexual polypites (Disconectæ).	Geschlechts-Siphonen.
sy	Pylorus (sphincter stomachi).	Pylorus.	Magen-Pförtner.
sz	Sphincter basalis.	Basal sphincter.	Basal Sphincter.
t	*Tentacula (Filamenta).*	*Capturing filaments.*	*Fangfäden.*
ta	Ampulla terminalis tentilli.	Terminal vesicle of the tentillum.	Endblase des Tentills.
tb	Basis tentaculi.	Basal portion of the tentacle.	Basal-Stück des Tentakels.
tc	Cornua lateralia tentilli.	Lateral horns of the tentillum.	Seiten-Hörner des Tentills.
td	Tentaculum primarium.	Larval tentacle.	Larven-Tentakel.
te	Filum terminale tentaculi.	Terminal filament of the tentacle.	Endfaden des Tentakels.
tf	Filum terminale tentilli.	Terminal filament of the tentillum.	Endfaden des Tentills.
tg	Suspensorium (mesenterium).	Ventral band of the tentacle.	Tentakel-Leitband.
th	Involucrum (pallium cnidosacci).	Mantle of the sacculus.	Mantel des Nesselknopfs.
ti	Internodia tentaculi.	Internodes of the tentacle.	Tentakel-Segmente.
tk	Cnidotænia (cnidosaccus tentilli).	Sacculus (urticating band).	Nesselband des Tentills.
tl	Ligamenta elastica tentilli.	Angle-bands (of the cnidotænia).	Elastische Bänder des Nesselknopfs.
tm	Musculi tentaculi.	Muscles of the tentacle.	Tentakel-Muskeln.
tn	Nodi tentaculi.	Nodes of the tentacle.	Tentakel-Knoten.
to	Ampulla basalis (Physalidarum).	Basal sac of the tentacle.	Basal-Blase des Tentakels.
tp	Pedunculus tentilli.	Pedicle of the tentillum.	Tentillen-Stiel.
tq	Cnidosphæria terminalia (Disconectarum).	Terminal cnidospheres.	Endfaden-Nesselkugeln.
tr	Annuli tentaculi.	Rings of the tentacles.	Tentakel-Ringe.
ts	Tentilla (tentaculi rami laterales).	Lateral branches of the tentacle (Accessory tentacles).	Seitenfäden des Tentakels (Tentillen).
tt	Tentilli basis (insertio).	Insertional base of the tentillum.	Tentillen-Insertion.
tu	Insertio subumbralis tentaculi (Disconectarum).	Insertional-facettes of the tentacles.	Tentakel-Insertions Narben.
tv	Villi tentaculi exodermales.	Exodermal villi of the tentacle.	Exoderm-Zotten des Tentakels.
tw	Verrucæ tentaculi.	Exodermal tubercles.	Nesselwarzen des Tentakels.
ty	Ocelli involucri.	Ocellar spots of the sacculi.	Augenflecke der Nesselknöpfe.
tz	Calcar tentilli.	Spur of the tentillum.	Tentillen-Sporn.
u	*Umbrella.*	*Umbrella.*	*Schirm.*
ua	Apex umbrellæ.	Top of the umbrella.	Schirm-Scheitel.
ub	Basis umbrellæ.	Base of the umbrella.	Schirm-Grund.
uc	Centradenia (Disconectarum).	Central gland.	Central-Drüse (der Disconecten).
ud	Facies dorsalis umbrellæ.	Dorsal face.	Rückenfläche des Schirms.
ue	Exumbrella.	Convexity of the umbrella.	Ober-Schirm.
uf	Velarium (Velellidarum).	Sail of the float of the Velellidæ.	Segel der Schwimmblase.
ug	Facies basalis umbrellæ.	Basal face of the umbrella.	Grundfläche.
uh	Hepar (Disconectarum).	Liver (of the centradenia).	Leber (der Central-Drüse).
ui	Infundibulum (hydrœcium).	Funnel-cavity.	Stamm-Gehäuse.
uk	Valvula infundibuli.	Valve of the funnel.	Gehäus-Klappe.

	Latin Scientific Term.	English Term.	German Term.
ul	Facies sinistra umbrellæ.	Left-hand face.	Linke Schirmfläche.
um	Margo umbrellæ.	Umbrella-margin.	Schirm-Rand.
un	Nephros (Disconectarum).	Kidney (of the centradenia).	Niere (der Central-Drüse).
uo	Ostium umbrellæ.	Mouth of the umbrella.	Schirmhöhlen-Mündung.
up	Pedunculus umbrellæ.	Pedicle of the umbrella.	Schirm-Stiel.
uq	Æquator umbrellæ.	Equatorial periphery.	Æquator des Schirms.
ur	Plicæ radiales umbrellæ (Disconectarum).	Radial folds of the umbrella.	Stern-Falten des Oberschirms.
us	Glandulæ marginales (Disconectarum).	Muciparous glands of the umbrella-margin.	Schleimdrüsen des Schirmrandes (der Disconecten).
ut	Sulcus tentacularis umbrellæ.	Ring furrow of the umbrella.	Tentakel-Kranz-Furche.
uu	Limbus umbrellæ.	Limb of the umbrella.	Schirm-Saum (der Disconecten).
uv	Facies ventralis umbrellæ.	Ventral face.	Bauchfläche.
uw	Cavitas umbrellæ.	Concavity of the umbrella.	Unter-Schirm.
ux	Facies dextra umbrellæ.	Right-hand face.	Rechte Schirmfläche.
uy	Ocelli marginales.	Eye-spots on the umbrella-margin.	Augen am Schirmrande.
uz	Fulcrum (gelatina umbrellæ).	Jelly-mass of the umbrella.	Schirmgallerte.
v	*Velum.*	*Velum* (*Nectoring*).	*Schwimmring.*
w	*Subumbrella.*	*Nectosac.*	*Schwimmsack.*
x	*Organa indefinita.*	*Undetermined organs.*	*Unbestimmte Organe.*
y	*Cystones.*	*Anal vesicles.*	*Afterblasen.*
z	*Fulcrum* (*Lamina fulcralis*).	*Supporting plate.*	*Stützplatte.*

APPENDIX.

STATISTICAL SYNOPSIS of the numbers of families, genera, and species of Siphonophoræ enumerated in this Report:—

Orders.	Plates of the Report.	Pages of the Report.	Families.	Genera.	Species.
ECTÆ, . . .	XLIII.–L.	26–88	3	9	36
II. CALYCONECTÆ, . . .	XXVII.–XLII.	89–183	6	29	94
III. PHYSONECTÆ, . . .	VIII.–XXI.	184–280	8	29	75
IV. AURONECTÆ, . . .	I.–VII.	281–304	2	4	5
V. CYSTONECTÆ, . . .	XXII.–XXVI.	305–352	5	14	30
Total, . .	. .	. .	24	85	240

PLATE I.

Order AURONECTÆ.

Family RHODALIDÆ.

Rhodalia miranda.

PLATE I.

Rhodalia miranda, n. sp. (p. 302).

Diam.

Fig. 1. Apical view of the corm (from above). The large spheroidal pneumatophore (*p*) is surrounded by the corona of pyriform nectophores (*n*). This corona is bisected in the sagittal axis by the aurophore (*l*) on the dorsal side, and by the series of buds (*i*) on the ventral side. *v*, Velum; *w*, opening of the nectosac, ... × 2

Fig. 2. A single cormidium, composed of a very contracted cylindrical siphon (*s*) and two gonodendra. One gonostyle bears a long sexual palpon (*r*). *sh*, Striæ hepaticæ; *sr*, proboscis; *so*, mouth, . . . × 15

Fig. 3. A single gonodendron, with two main branches, bearing clusters of numerous pear-shaped ovaria (*f*) and scattered spindle-shaped spermaria (*h*). *c*, Spirally twisted canal of the contracted gonostyle, . × 15

Fig. 4. Transverse section through a gonostyle, or the stem of a gonodendron. The transverse section through the basal pedicle of a siphon exhibits nearly the same structure. *c*, Central canal; *d*, entoderm; *e*, exoderm; *z*, structureless, cartilaginous, supporting plate; z^1, its radial branched apophyses covered outside by the transverse sections of longitudinal muscles (*ml*). Inside, between it and the entoderm, a thin layer of ring-muscles (*mc*), ... × 70

Fig. 5. A fragment of the same transverse section. Characters as in fig. 4, . × 200

RHODALIA MIRANDA

PLATE II.

Order AURONECTÆ.

Family RHODALIDÆ.

Rhodalia miranda

PLATE II.

Rhodalia miranda, n. sp. (p. 302).

Diam.

Fig. 6. Basal view of the corm (from below). The tentacles are detached and the siphons highly contracted. The whole convex basal surface of the corm is covered by radish-shaped cormidia, each of which is usually composed of a siphon (s) and one or two gonodendra (g). The nectophores (n) form a peripheral corona. v, Velum; w, opening of the nectosac (compare p. 290), ... × 2

Fig. 7. A single branch of a clustered gonodendron, with numerous pear-shaped gynophores and single, scattered, spindle-shaped androphores, ... × 50

Fig. 8. A single branch of a gonodendron, with two monovonian and two polyovonian gynophores, ... × 50

Fig. 9. Longitudinal section through a polyovonian gynophore. c, Gastral cavity; d, entoderm; e, exoderm; o, ovules; o^1, nucleolus (germinal spot); o^2, nucleus (germinal vesicle); o^3, protoplasm of the egg-cell (germinal yolk), ... × 150

Fig. 10. Transverse section through a polyovonian gynophore. Characters as in fig. 9, ... × 150

Fig. 11. A pyriform polyovonian gynophore, from the outside of which arise two secondary monovonian gynophores, ... × 50

Fig. 12. An ovate monovonian gynophore, the umbrella of which exhibits eight distinct radial canals (instead of the usual four), . . . × 50

RHODALIA MIRANDA

PLATE III.

Order AURONECTÆ.

Family RHODALIDÆ.

Rhodalia miranda.

PLATE III.

Rhodalia miranda, n. sp. (p. 302).

Diam.

Fig. 13. Lateral view of the corm (from the left side), somewhat diagrammatic. The triple corona of nectophores may exhibit in the living animal a somewhat different form; all the nectophores of the spirit-specimens examined were strongly contracted and altered by the action of the alcohol; the majority, too, were detached from the stem. The siphons and tentacles were all detached from the trunk, also very highly contracted, and it is probable that they exhibit in living specimens a larger size and a more peculiar form. The upper half of the figure exhibits the nectosome from the left side; most nectophores in the right half of the figure are removed, in order to show the high insertions of their lamellar pedicles. Beyond the cap-shaped apical pneumatophore the dorsal aurophore is visible on the right hand. The lower half of the figure exhibits the siphosome, densely covered with numerous cormidia, each with a contracted siphon, a long tentacle, and a clustered gonodendron (compare p. 290), . × 2

Fig. 14. Dorsal view of the same corm. The majority of the nectophores are removed from the trunk of the nectosome, the high insertions only of their lamellar pedicles being visible. A few nectophores remain on the right and left. Beyond the cap-shaped apical pneumatophore is visible in the median dorsal groove of the trunk the spheroidal aurophore, with its external opening, the aurostigma. The trunk of the siphosome (in the lower half of the figure), and the numerous cormidia covering it, are highly contracted; all the tentacles are detached; between the clustered gonodendra are visible the strongly retracted siphons, ... × 2

RHODALIA MIRANDA.

PLATE IV.

Order AURONECTÆ.

Family RHODALIDÆ.

Rhodalia miranda.

PLATE IV.

Rhodalia miranda, n. sp. (p. 302).

Diam.

Fig. 15. Sagittal section through the complete corm, in the vertical median plane. *p*, Pneumatophore; *pa*, its wide cavity filled with air; *l*, aurophore; *lm*, its pistil; *lo*, its external opening (aurostigma); *i*, ventral series of buds; *n*, young ventral nectophore; *np*, peduncle of a dorsal nectophore; *a*, cartilaginous bulb of the trunk; *ac*, reticulum of the trunk-vessels; *aa*, large flat hypocystic cavity of the trunk, beyond the pneumatophore; *ab*, cormidia; *g*, gonodendron; *r*, gonopalpon; *s*, siphon, ... × 2

Fig. 16. Apical view of the corm (from above), after removal of the nectophores and the greatest part of the pneumatophore; the horizontal section lying somewhat above the bottom of the float (*pa*). The corona of white rays, which surrounds it, represents the transverse sections of the pedicles of the nectophores (np^1), and this is surrounded by the peripheral corona of cormidia (*g*). The auroduct (or the central canal of the aurophore, *la*) opens inside by the auropyle (*li*), outside by the aurostigma. *pl*, Foveola; *l*, aurophore (in the median line of the dorsal side); *lr*, radial chambers of the aurophore; *i*, series of buds (in the median line of the ventral side); *ic*, dorsal canal of the trunk (for the buds); *np*, peduncle of the nectophore; *g*, corona of the gonophores. A single nectophore (*n*) remains. *v*, Velum; *w*, ostium of the subumbrella.

Fig. 17. Series of buds on the ventral side of a young corm (blastocrene of the siphosome), immediately beyond the pneumatophore. *n*, Young nectophore; *nc*, its ring-canal; *v*, velum; *w*, subumbrella; *ab*, cormidia, or groups of buds, developed in a spiral; each group being composed of a siphon (*s*) and a gonodendron (*g*), ... × 5

Fig. 18. A young gonodendron, with two branches, one of which bears a long cylindrical palpon (*q*). *ga*, Gonostyle; *gc*, its canal; *g*, gonophores, ... × 10

Fig. 19. A single siphon. *sp*, Pedicle; *ml*, longitudinal muscles of the stomach; *sh*, remnants of the hepatic stripes; *sr*, proboscis; *so*, mouth, ... × 1

Fig. 20. A detached siphon, connected with its tentacle. *sp*, Pedicle of the siphon; *sh*, hepatic ridges; *sr*, proboscis; *t*, tentacle; *ts*, tentilla (compare pp. 290 to 292), ... × 5

Fig. 21. Transverse section of a tentacle. *c*, Central canal; *d*, entoderm; *mc*, ring-muscles; *z*, fulcrum; *ml*, longitudinal muscles; *e*, exoderm (compare p. 292), ... × 100

Fig. 22. A portion of a tentacle with the insertions of the tentilla (*ts*). *tr*, Rings of the tentacle, . × 20

Fig. 23. A single tentillum. *tb*, Basal pedicle; *tk*, cnidoband; tk_1, large lateral cnidocysts; tk_{11}, small median cnidocysts; *tl*, elastic ligament (angle-band); *tf*, terminal filament, . . × 200

RHODALIA MIRANDA.

PLATE V.

Order AURONECTÆ.

Family RHODALIDÆ.

Rhodalia miranda.

PLATE V.

All the figures of this Plate, except figs. 30 and 31, represent different sections through the aurophore.

Rhodalia miranda, n. sp. (p. 302).

Diam.

Fig. 24. Sagittal section through the aurophore and the neighbouring parts of the pneumatophore. The thick wall of the pyriform medusoid aurophore contains a lacunar system of wide irregular canals (*lr*), separated by radial, irregularly branched septa. The aurostigma (*lo*), or the distal opening of the aurophore, leads into a narrow central axial canal (*la*), and the proximal end of this auroduct, the auropyle (*li*), opens into the large cavity of the pneumatocyst (*pa*). The auroduct is placed in the axis of a muscular cylinder, the pistil (*lp*), which fills up the subumbrellar cavity of the medusoid aurophore. The pistil is surrounded by a thickened cylindrical cuticular vagina (*lf*), seemingly the distal prolongation of the pneumatocyst (*pf*). *ps*, Pericystic cavity (between outer, *z*, and inner, z^1, wall of the pneumatophore); *ac*, gastral canals of the trunk, traversing its hyaline cartilaginous jelly-substance (z^1); *z*, fulcrum; *d*, entoderm; *e*, exoderm, . × 1

Fig. 25. Frontal section (or vertical transverse section) through the basal part of the aurophore of another specimen. *la*, Axial canal of the pistil; *le*, its lining epithelium (exodermal); *lp*, longitudinal muscles of the pistil (seen in transverse section); *lf*, vagina pistilli (cuticular tube); e^1, exoderm of the inner wall of the aurophore (subumbrella?); e^2, exoderm of its outer wall (exumbrella?); *d*, entoderm; *z*, fulcrum; *lr*, radial pouches and lacunar canals, with radial septa between them. The upper part of the figure exhibits the insertion of the aurophore at the dorsal base of the pneumatophore. *pf*, Pneumatocyst; *pa*, cavity of the pneumatocyst, ... × 15

Fig. 26. Frontal section through the middle part of the aurophore of the same specimen. The characters are the same as in fig. 25, ... × 15

Fig. 27. A small fragment of the exumbrella (or the outer wall) of the aurophore, taken from the transverse section, fig. 26. Two inner folds of the exumbrella are seen in vertical section (through their fulcral axis). *e*, Exoderm; *z*, fulcrum; *d*, entoderm, . . . × 150

Fig. 28. A small portion of a longitudinal section through the pistil of the aurophore. *la*, Axial canal (auroductus); *le*, its epithelium; *lm*, bundles of parallel, longitudinal, spindle-shaped cells (apparently muscle-cells); *ln*, their nuclei; outside is the vagina pistilli (cuticular tube, compare fig. 24), ... × 300

Fig. 29. Transverse section through a canal (*ac*) of the reticulum of the trunk; the entodermal epithelium (*d*) of the canal is simple, and surrounded by the hyaline structureless fundamental substance of the cartilaginous support, ... × 150

Fig. 30. A small portion of a vertical section through the pneumatocodon (or the exumbrella of the pneumatophore). One of the simple or forked bands of entoderm-cells (d_1), which traverse the cartilaginous fulcrum (*z*), connects the entoderm of the exumbrella (*d*) with its exoderm (*e*), ... × 150

Fig. 31. Lateral view of the inferior part of the lamellar peduncle of a nectophore. The fine parallel stripes (vertical in the figure) are horizontal (or radial) muscle-fibrillæ (*nm*). A strong peduncular canal (*ns*), arising from the trunk, runs along the inferior free horizontal margin of the peduncle (right hand of the figure), and gives off a series of twenty to thirty small, simple, secondary canals (*nl*). These ascend vertically; their size decreases from the inner (axial) towards the outer (abaxial) margin of the peduncle, . . . × 15

RHODALIA MIRANDA

PLATE VI.

Order AURONECTÆ.

Family STEPHALIDÆ.

Stephonalia bathyphysa.

PLATE VI.

Stephonalia bathyphysa, n. sp. (p. 299).

N.B.—Since this species was formerly confused by me with *Stephalia corona*, it bears the name of this species on the Plate.

Diam.

Fig. 32. Lateral view of the corm, from the left side. *p*, Pneumatophore; *l*, aurophore; *n*, nectophore; *s*, siphons; *t*, tentacles; *g*, gonodendra; *ap*, protosiphon, ... × 4

Fig. 33. Dorsal view of the same corm. Characters as in fig. 32. *lo*, Aurostigma, ... × 4

Fig. 34. Apical portion of the siphosome of another corm, exhibiting the spiral series of young cormidia, which are developed immediately beyond the pneumatophore (*p*). The single cormidia are isolated and more highly magnified in figs. 35–38. *s*, Siphons; *t*, tentacles; *g*, gonodendra; *n*, nectophores.

Fig. 35. A group of six cormidia, arising from a common pedicle (*ab*). The numbers I.–VI. mark the succession in age and size; I. is the youngest, VI. the oldest cormidium. *s*, Siphons; *sg*, stomach (with eight to twelve dark liver-stripes, *sh*); *sr*, proboscis; *sr'*, the same reflexed; *t*, the annulated tentacle; *tf*, its terminal filament; *g*, gonodendra, ... × 20

Fig. 36. A very young cormidium, with a few buds.

Fig. 37. A single isolated cormidium. Characters as in fig. 35. *sp*, Pedicle of siphon; *sb*, basigaster; *q*, gonopalpon, ... × 20

Fig. 38. A single, well-developed cormidium, to the basal pedicle of which is attached a cluster of very young, incipient cormidia, . . × 20

STEPHALIA CORONA.

PLATE VII.

Order AURONECTÆ.

Family STEPHALIDÆ.

Stephalia corona.

Figs. 42, 46, *Rhodalia miranda.*)

PLATE VII.

Stephalia corona, n. sp. (p. 297).

Diam.

Fig. 39. Lateral view of a young corm (in profile, from the right side). *p*, Pneumatophore; *l*, aurophore; *lo*, auropyle; *n*, corona of nectophores; *uo*, ostium of the nectosac; *cc*, ring-canal; *s*, siphons; *t*, tentacles; below, central siphon (basal opening of the trunk), . . × 10

Fig. 40. Sagittal section through the same corm; signification of the characters the same as in fig. 39. Beyond the pneumatophore (*p*) is visible the hypocystic cavity (*ah*), and on its dorsal side the aurophore (*l*). From the centre of the hypocystic cavity arises the central axial canal (*ca*); it passes through the vertical axis of the cartilaginous trunk (*a*), gives off numerous anastomosing branches (*ac*), and opens through the mouth of the central siphon (*ap*). *i*, Ventral series of buds. Each siphon (*s*) bears a simple tentacle (*t*) on the dorsal side of its base, but no gonodendron, ... × 10

Fig. 41. The distal end of another corm. *ao*, The prostoma, or the basal mouth-opening of the primary siphon (afterwards the axial canal, *ca*, of the trunk, *ap*), . . . × 20

Fig. 42. A single siphon of *Rhodalia miranda*, with a tentacle. *sp*, Pedicle; *sb*, basigaster; *sg*, stomach; *sh*, hepatic ridges; *sr*, proboscis; *so*, mouth; *tr*, rings of the tentacle; *tg*, its suspensorium; *tt*, insertions of the tentilla (*ts*); these are lost in the distal part (at the right hand), . × 10

Fig. 43. Two large ensiform cnidocysts, from the lateral series of the tentillum; A, closed; B, opened, with protruded cnido-filament, ... × 400

Fig. 44. Bud of a nectophore, in longitudinal section. *np*, Peduncle; *w*, subumbrellar cavity; *v*, incipient velum; *c*, gastral cavity; *d*, entoderm; *e*, exoderm; *z*, fulcrum, . . × 100

Fig. 45. Bud of a nectophore, in transverse section. Characters the same as in fig. 44. The four radial canals (*nr*) are visible, between the cathamma (*d*), ... × 100

Fig. 46. A mature androphore of *Rhodalia miranda*. *hs*, Spermarium; *hx*, spadix; *hr*, radial canals of the umbrella (*u*); *uo*, ostium of the umbrella, ... × 50

Fig. 47. Muscle-epithelium of the outside of the pneumatophore. *c*, Exoderm-cells, . . . × 300

Fig. 48. Lateral view of a corm of *Stephalia corona* (from the right side). *p*, Pneumatophore; *l*, aurophore; *n*, nectophores; *np*, their pedicles; *v*, velum; *s*, siphons; *so*, their mouth-openings; *g*, gonophore-buds; *ap*, protosiphon, ... × 5

Fig. 49. A single cormidium of another specimen. *ab*, Common pedicle of the cormidium; *s*, siphon; *so*, its mouth; *ga*, gonostyle; *f*, gynophores; *o*, eggs; *k*, androphore, . . . × 50

Fig. 50. A young larva (*Auronula*). *pa*, Cavity of the pneumatophore; *l*, aurophore; *lm*, its pistil; *lo*, aurostigma; *ap*, primary siphon; *sc*, its cavity; *ao*, its mouth; *e*, exoderm; *d*, entoderm, ... × 10

STEPHALIA CORONA

PLATE VIII.

Order PHYSONECTÆ.

Family FORSKALIDÆ.

Forskalia tholoides.

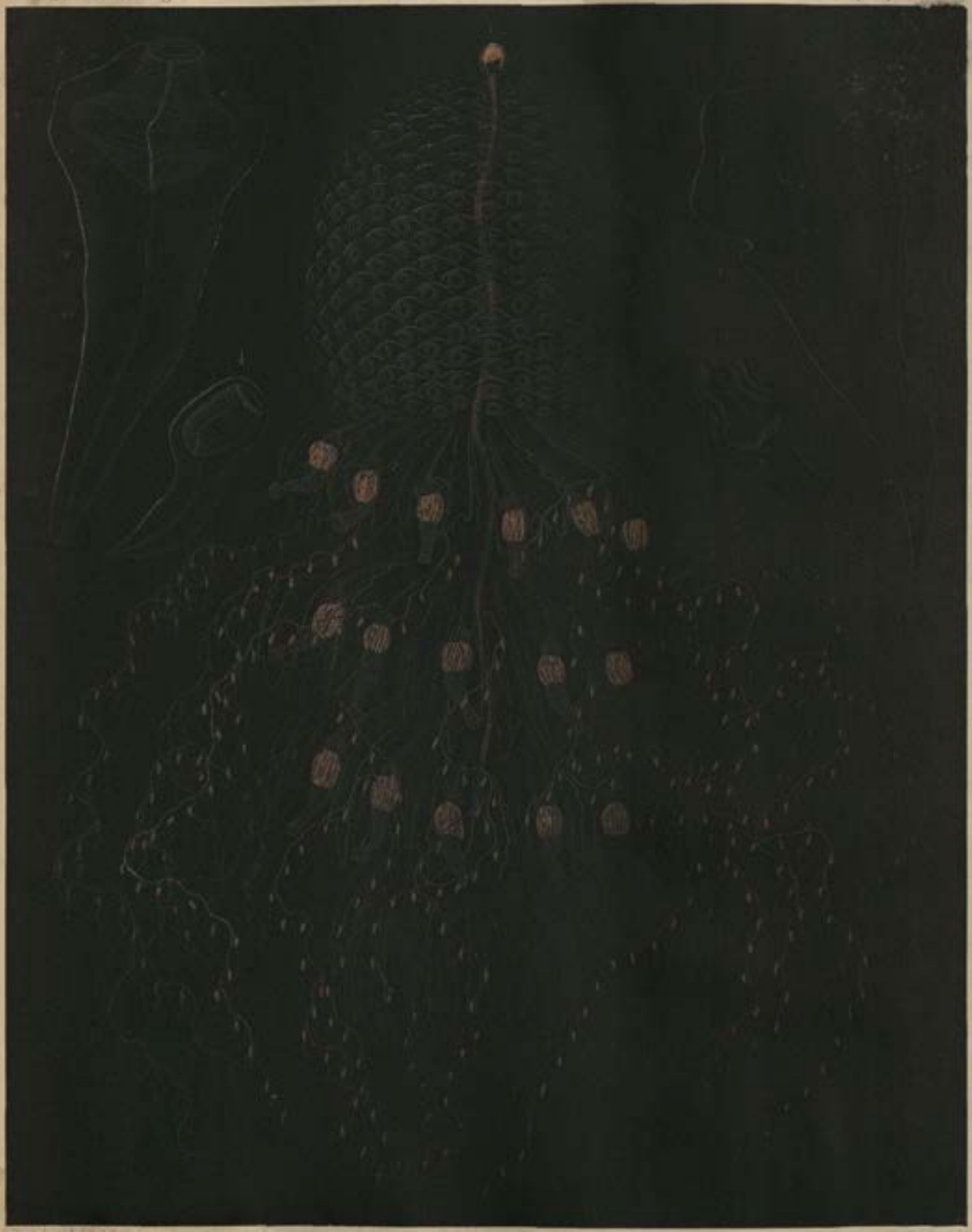
PLATE VIII.

Forskalia tholoides, n. sp. (p. 244).

Diam.

Fig. 1. Lateral view of a complete corm, drawn by me from life in Lanzerote, in December 1866. The cupola-shaped nectosome bears on the top a small red pneumatophore, and is composed of very numerous nectophores, arranged like the scales of a fir-cone in a læotropic spiral series. The siphosome exhibits numerous siphons which are attached to the axial stem by long radial pedicles, and arranged in a dexiotropic spiral series. The stomachs of the siphons are red. Each siphon bears on its base a long tentacle, beset with a series of numerous tentilla; the cnidobands of the latter are also pink. The whole surface of the siphosome is covered with large dentate bracts, . × 2

Figs. 2–5. Lateral view of four isolated nectophores (2 and 3 fully developed, 4 and 5 young ones). *np*, Triangular pedicle; *nb*, its base of insertion into the trunk; *ns*, canal of the pedicle; *nr*, four radial canals; *nc*, ring-canal; *v*, velum, . × 8



FORSKALIA THOLOIDES.

PLATE IX.

Order PHYSONECTÆ.

Family FORSKALIDÆ.

Forskalia tholoides.

PLATE IX.

Forskalia tholoides, n. sp. (p. 244).

Fig. 6. Apical view (from above) of a complete corm (without nectophores and bracts), preserved in spirit, in a state of extreme contraction. All the nectocalyces and the hydrophyllia are detached. The nectosome exhibits beyond the pneumatophore (*p*) a multiple series of small tubercles, the basal insertions of the pedicles of the detached nectophores (*n*). The shortened trunk of the siphosome (*a*) is vesicular and inflated. The siphosome exhibits the dexiotropic spiral line in which the loose cormidia are arranged. *s*, The contracted siphons; *t*, tentacles; *q*, palpons; *r*, palpacles; *i*, buds.

Fig. 7. A single loose cormidium, attached to the articulated trunk, with a single siphon and a single tentacle. The long extended pedicle of the siphon (*sp*) is covered by some denticulate bracts or hydrophyllia (*b*). From the thickened basal part of the siphon (*sb*) there arises the long articulated tentacle bearing numerous tentilla, each with a spiral cnidoband (*k*). The dilated stomach of the siphon (*sm*) exhibits sixteen longitudinal hepatic ridges (*sh*), eight longer alternating with eight shorter. *sr*, Proboscis; *so*, mouth. A pediculate gonopalpon (*q*) bears on its base a thin palpacle (*r*) and a clustered monostylic gonodendron, composed of proximal gynophores (*f*) and distal androphores (*h*). *qp*, Pedicle of the palpon; behind the gonopalpon is a cyston; *b*, bract; *an*, nodal constrictions of the trunk, from which all the appendages arise; *ai*, internodes; *ac*, red central canal of the trunk.

Fig. 8. A single siphon, highly contracted. *so*, Mouth; *sl*, sixteen radial folds of the reflexed proboscis; *sm*, stomach with sixteen red hepatic ridges; *sb*, four square cnidal plates of the basigaster; *sp*, pedicle of the siphon; *t*, tentacle (arising in the constriction between pedicle and basigaster).

Fig. 9. Two cnidal nodes of the mouth-opening; from each arise two longitudinal glandular ridges, running between the muscles inside the proboscs.

FORSKALIA THOLOIDES.

PLATE X.

Order PHYSONECTÆ.

Family FORSKALIDÆ.

Forskalia tholoides.

PLATE X.

Forskalia tholoides, n. sp. (p. 244).

Figs. 10–18. Different forms of detached hydrophyllia or bracts.

Fig. 10. Lateral view of a small bract.
Fig. 11. Facial view of the same.
Fig. 12. Lateral view of another small bract.
Fig. 13. Facial view of the same.
Fig. 14. Dorsal view of another bract.
Fig. 15. Lateral view (profile) of the same.
Fig. 16. Transverse section of the same.
Figs. 17, 18. Two larger bracts of different forms.

Fig. 19. An isolated cyston (*q*), with its palpacle or tasting filament (*r*). *qp*, Pedicle, compare p. 246.

Fig. 19—A, B, C. Three different states of contraction of the palpacle (fig. 19).

Fig. 20. A single palpon, separated from its pedicle by a basal cnidoring (*qb*) (p. 247).

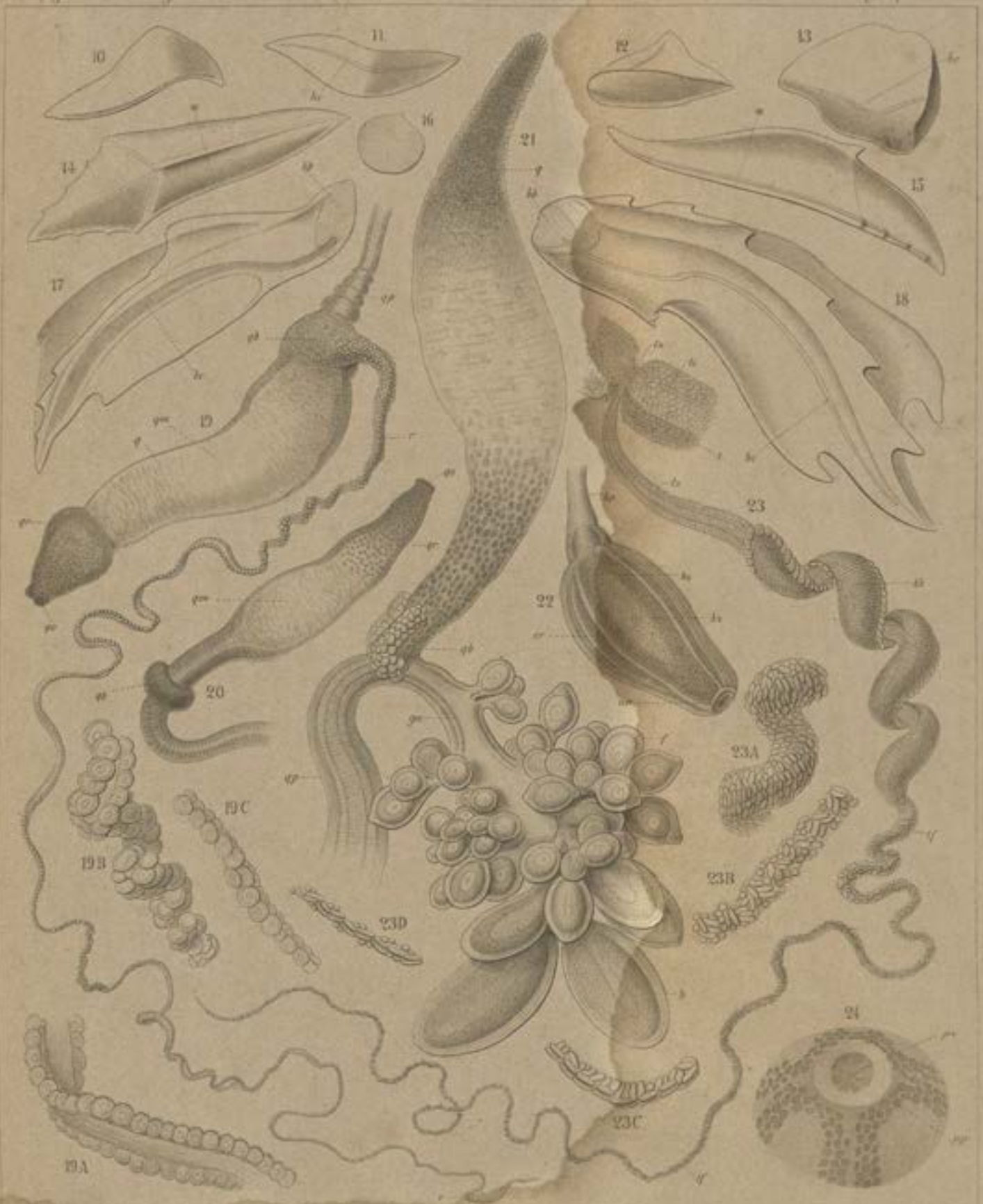
Fig. 21. A single pediculate gonodendron. *q*, Gonopalpon or sexual palpon, bearing on its base a pair of crescentic cnidonodes (*qb*); *ga*, cluster of gonophores; *f*, gynophores; *h*, androphores; *qp*, gonostyle (common pedicle of the palpon and the gonodendron).

Fig. 22. An isolated androphore. *uo*, Umbrella aperture; *hx*, spadix; *hs*, spermarium; *hp*, pedicle.

Fig. 23. A single tentillum, arising from a nodal constriction of the tentacle (*tn*). *ts*, Pedicle; *tk*, cnidoband; *tf*, terminal filament.

Fig. 23—A, B, C, D. Four different stages of contraction of the terminal filament (*tf*, fig. 23).

Fig. 24. Apex of the pneumatophore, with four pairs of pigment radii (p. 244).



FORSKALIA THOLOIDES.

PLATE XI.

Order PHYSONECTÆ.

Family ANTHOPHYSIDÆ.

Athorybia ocellata.

PLATE XI.

The figures of this Plate were painted by me from living specimens, which I observed in the Canary Island Lanzerote, December 29, 1866.

Athorybia ocellata, n. sp. (p. 276).

Fig. 1. Lateral view of the complete corm, in an expanded state, quietly floating at the surface of the sea (*xy*). The pneumatophore (*p*) bears a red pigment-cap and is surrounded by a corona of crescentic elegantly ribbed bracts (*b*). Between these are numerous prominent palpons (*q*), with a red ocellus on the apex (*qo*). Below depend five siphons and tentacles; *ss*, suctorial disc of the mouth.

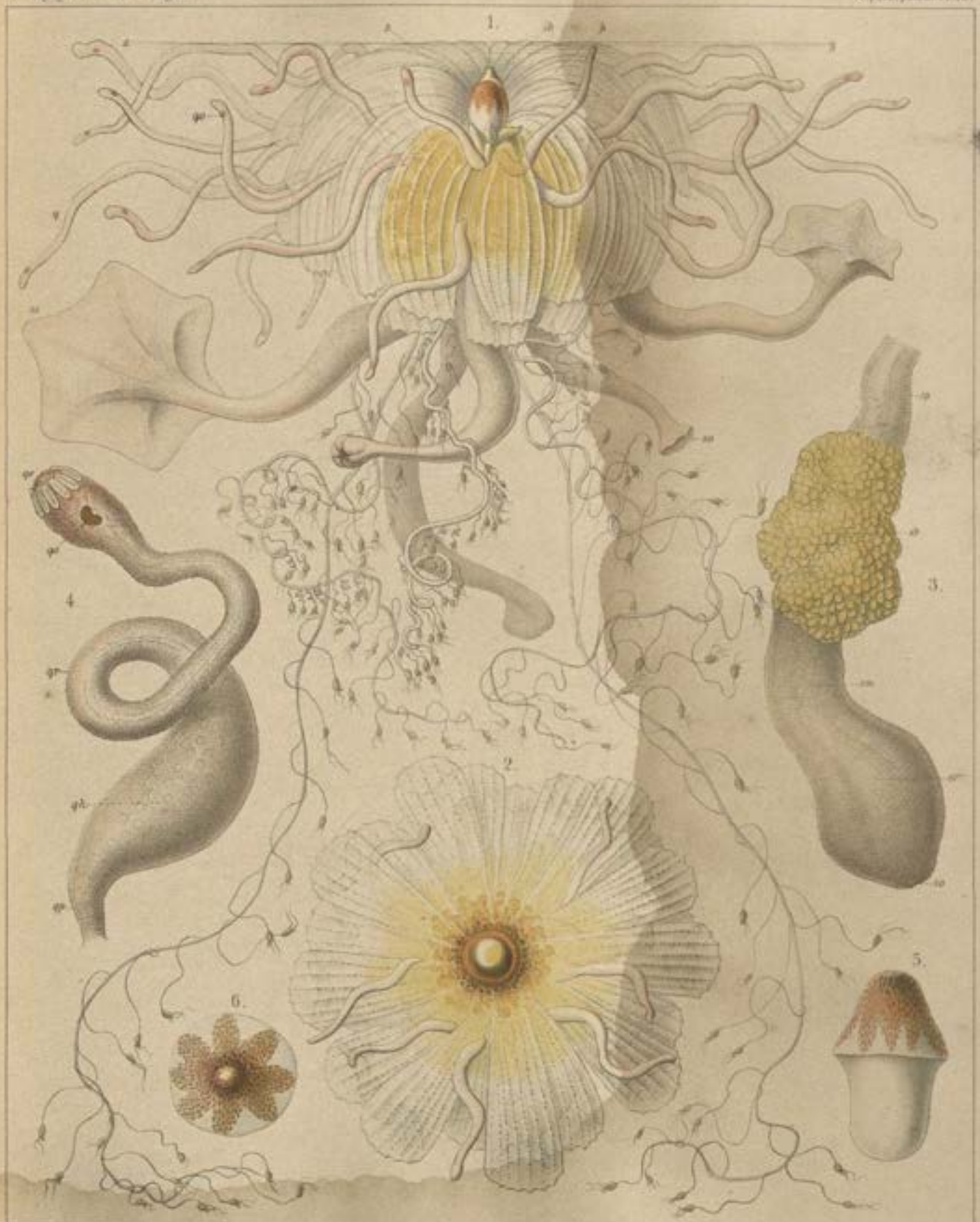
Fig. 2. Apical view of the same corm (from above).

Fig. 3. A single siphon. *sp*, Pedicle; *sb*, basigaster; *sm*, stomach; *sr*, proboscis; *so*, mouth (p. 277).

Fig. 4. A single palpon. *qp*, Pedicle; *qo*, ocellus (with a lens?); *qc*, terminal corona of cnidocysts.

Fig. 5. Lateral view of the isolated pneumatophore.

Fig. 6. Apical view of the same, with the octoradiate pigment-cap (mitra ocellaris).



ATHORYBIA OCELLATA

PLATE XII.

Order PHYSONECTÆ.

Family ANTHOPHYSIDÆ.

Figs. 7–9. *Anthophysa darwinii.*
Figs. 10–18. *Athorybia ocellata.*

PLATE XII.

Figs. 7–9. *Anthophysa darwinii*, n. sp. (p. 278).

Fig. 7. Dorsal view of the complete corm, after the detachment of the bracts. The ovate pneumatocyst (*p*) exhibits above an octoradiate pigment-star, below a corona of sixteen radial septa. *bp*, Basal insertions of the lamellar pedicles of bracts; *ib*, buds of bracts, on the top of the nectostyle; below, trunk of the nectosome; *q*, palpons.

Fig. 8. Lateral view of the same corm, without bracts (from the left side). Characters as in fig. 7. The ventral side of the pneumatophore is embraced by the cucullate nectostyle (*am*); (compare p. 279).

Fig. 9. Ventral view of the same corm. Characters as in fig. 7. Two bracts only (*b*, at the left hand) are preserved. *is*, Ventral series of buds of cormidia (in the median ventral line of the siphostyle, p. 270).

Figs. 10–18. *Athorybia ocellata*, n. sp. (p. 276, Pl. XI.).

Fig. 10. Longitudinal section through a contracted siphon. *sp*, Pedicle; *sb*, basigaster; *sm*, stomach; *sv*, hepatic villi; *sr*, proboscis; *so*, mouth.

Fig. 11. Ventral view of a tentillum. *ts*, Pedicle; *tk*, cnidosac; *tc*, lateral horns; *ta*, terminal ampulla.

Fig. 12. Dorsal view of a tentillum; *tz*, dorsal spur. Characters as in fig. 11.

Fig. 13. Lateral view of a tentillum (left side). Characters as in figs. 11, 12. (For the right hand *ta* read *tz*.)

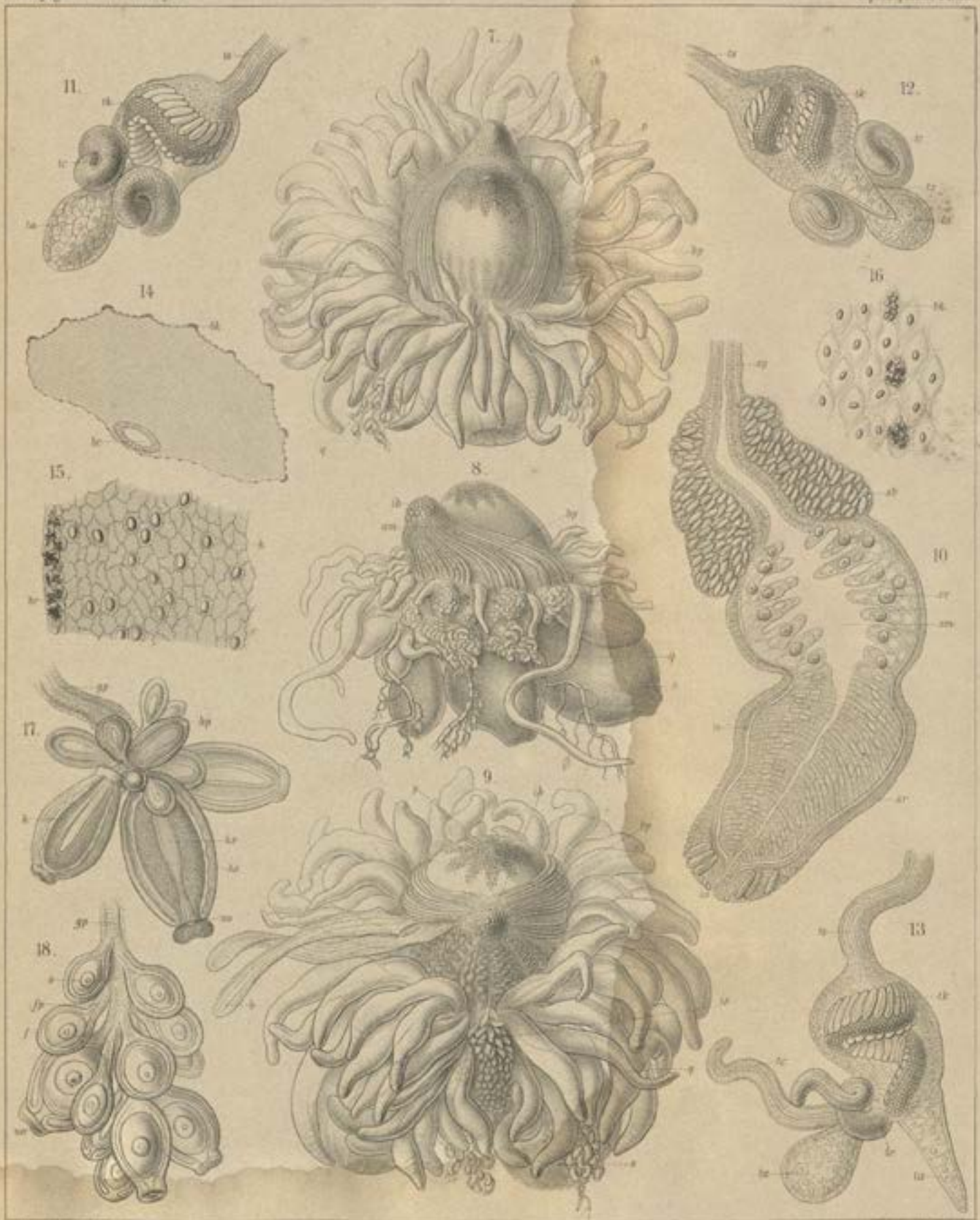
Fig. 14. Transverse section of a bract. *bc*, Bracteal canal; *bk*, cnidal ribs on the dorsal side.

Fig. 15. Exodermal epithelium of the margin of a bract. *br*, Cnidal marginal band, with pigment; *k*, cnidocysts.

Fig. 16. Exodermal epithelium of a dorsal rib of a bract. *bk*, Patches of pigment and cnidocysts.

Fig. 17. A male gonodendron. *gp*, Its pedicle; *h*, androphores; *hp*, their pedicles; *hx*, spadix; *hs*, spermarium; *uo*, ostium umbrellæ.

Fig. 18. A female gonodendron. *gp*, Its pedicle; *f*, gynophores; *fp*, their pedicles; *o*, eggs; *uo*, ostium umbrellæ.



E. Haviland and A. Inkson Del. J. Bonnet, Jun. Lithogr.

ATHORYBIA OCELLATA

PLATE XIII.

Order PHYSONECTÆ.

Family NECTALIDÆ.

Nectalia loligo.

PLATE XIII.

Drawn from life by me in Lanzerote, January 15, 1867.

Nectalia loligo, n. sp. (p. 252).

Fig. 1. Lateral view of the complete corm. The trunk of the nectosome bears an apical pneumatophore (*p*), with pneumatocyst (*pf*), and two opposite rows of nectophores (*n*). The shortened trunk of the siphosome bears a corona of bracts, and beyond it siphons (*s*), palpons and tentacles (*t*); *in*, buds of nectophores.

Fig. 2. The same corm in the contracted state, after the detachment of the nectophores. *pf*, Pneumatocyst; *in*, buds of nectophores; *is*, buds of siphons; *sb*, basigaster; *sm*, stomach; *sv*, hepatic villi; *sr*, proboscis; *so*, mouth; *yh*, cystons; *yo*, their distal opening (anus ?).

Fig. 3. The trunk alone, after the detachment of the appendages (lateral view from the left side). *am*, Nectostyle (trunk of the nectosome); *p*, pneumatophore; *pf*, pneumatocyst; *in*, buds of nectophores; *as*, vesicular siphostyle (trunk of the siphosome); *is*, buds of siphons and palpons.

Fig. 4. The pneumatophore (much contracted in spirit). *px*, Apex; *pb*, basis; *pf*, pneumatocyst; *pr*, four radial septa; *ps*, pouches between them; *in*, buds of nectophores, *am*, trunk of the nectosome.

Fig. 5. A young nectophore, from the ventral side.

Fig. 6. An adult nectophore, from the dorsal side. *w*, Subumbrella; *cl*, left canal; *cx*, right canal; *cp*, pedicular canal; *v*, velum.

Fig. 7. Basal view of a nectophore. *no*, Ostium; *v*, velum; *cc*, ring-canal.

Fig. 8. Lateral view of a nectophore, from the left side. *cl*, Left canal; *cp*, pedicular canal.

Fig. 9. Ventral view of a sagittal bract. *bb*, Basal pedicle; *cb*, ventral canal of the bract.

Fig. 10. Lateral view of an intermediate (diagonal) bract. Characters as in fig. 9. *bd*, Dorsal crest.

Fig. 11. Dorsal view of a lateral bract. Characters as in figs. 9, 10.

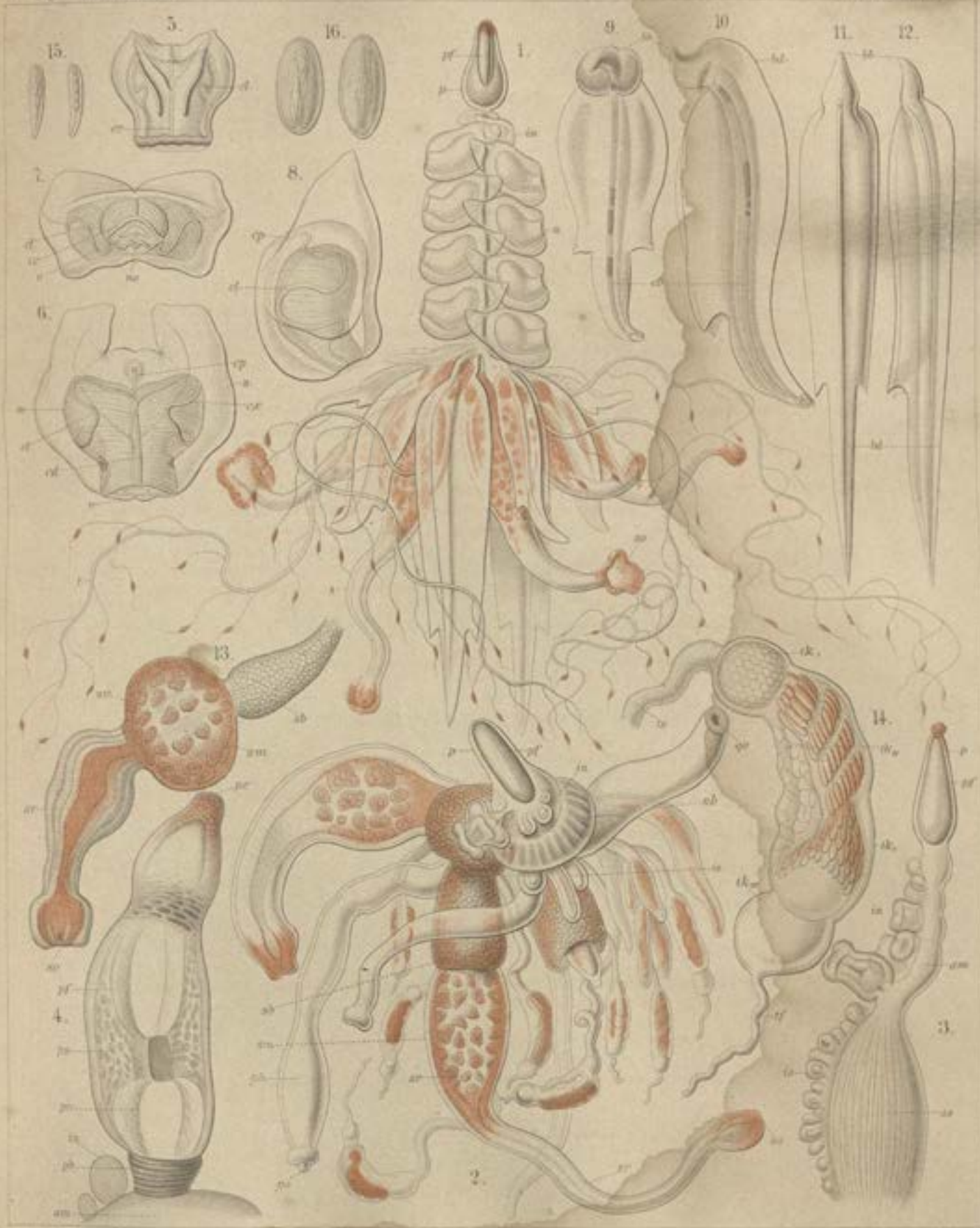
Fig. 12. Lateral view of the same lateral bract.

Fig. 13. A siphon. *sb*, Basigaster; *sm*, stomach, with hepatic villi (*sv*); *sr*, proboscis; *so*, mouth.

Fig. 14. A tentillum (lateral branch of a tentacle). *ts*, Pedicle; tk_{I}, basal ampulla; tk_{IV}, cnidoband; tk_{II}, cnidosac; tk_{III}, terminal ampulla; *tf*, terminal filament.

Fig. 15. Two small paliform cnidocysts, from the distal portion of the cnidoband.

Fig. 16. Two large ellipsoidal cnidocysts, from the basal portion of the cnidoband.



NECTALIA LOLIGO.

PLATE XIV.

Order PHYSONECTÆ.

Family AGALMIDÆ.

Anthemodes ordinata.

PLATE XIV.

Drawn from life by me in Lanzerote, January 25, 1867.

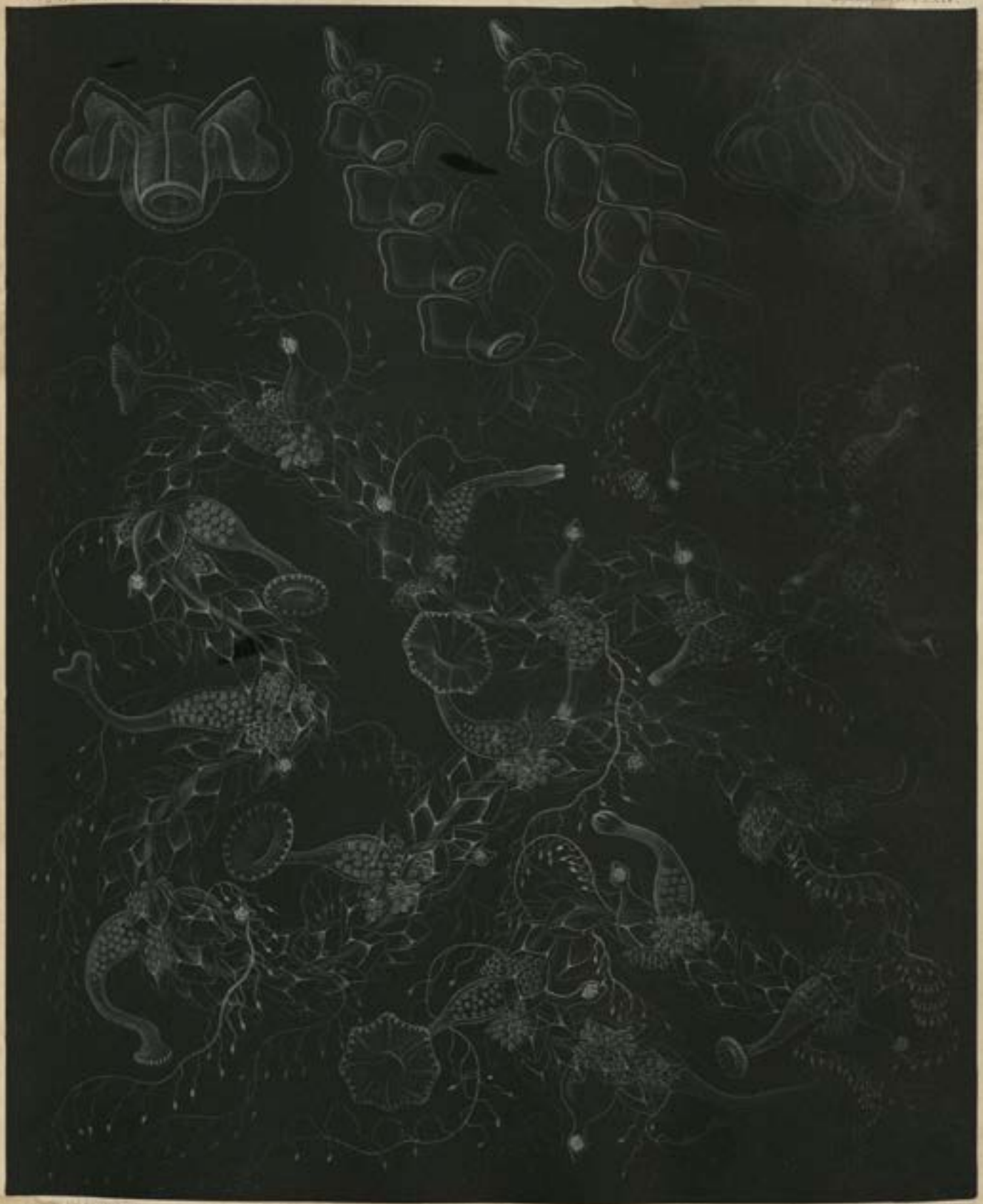
Anthemodes ordinata, n. sp. (p. 229).

Fig. 1. The complete corm, in the expanded state. The nectosome (seen from the lateral side) is composed of a small apical pneumatophore and two opposite rows of nectophores. The long tubular trunk of the siphosome is densely covered with prismatic bracts, and bears numerous ordinate and equidistant cormidia, each composed of a siphon, a tentacle, a cyston, and two gonodendra, a male and a female. (Compare Pl. XV. fig. 5.)

Fig. 2. The nectosome of the same corm, seen from the ventral (or dorsal) side.

Fig. 3. A single nectophore, dorsal view (from above and outside).

Fig. 4. A single nectophore, lateral view (from the left side).



ANTHEMODES ORDINATA.

PLATE XV.

Order PHYSONECTÆ.

Family AGALMIDÆ.

Anthemodes ordinata.

PLATE XV.

Anthemodes ordinata, n. sp. (p. 229).

Fig. 5. A single cormidium. *s*, Siphon; *sm*, stomach; *sr*, proboscis; *ss*, suctorial disc; *t*, tentacle; *y*, cyston; *yo*, its mouth (anus); *b*, bracts; *cb*, bracteal canal; *h*, androphores; *f*, gynophores.

Fig. 6. A single cormidium, attached to the trunk (*a*), without gonodendra. Characters as in fig. 5; *ts*, tentilla; *k*, cnidosac; *so*, mouth of the siphon.

Fig. 7. A single siphon. *sp*, Pedicle; *sm*, stomach; *sv*, hepatic villi (in four rows); *sr*, proboscis; *so*, mouth; *t*, tentacle; *k*, cnidosac.

Fig. 8. A single cyston. *yp*, Pedicle; *y*, excretory vesicle; *yc*, concretions; *yo*, mouth.

Fig. 9. Distal end of a cyston, with opened mouth, or rather anus (*yo*).

Fig. 10. Edges of a bract, with their rows of cnidocysts.

Fig. 11. A single tentillum. *ts*, Pedicle; *tv*, its villi; *kg*, large proximal cnidocysts; *km*, median paliform cnidocysts; below, distal pyriform cnidocysts; *tf*, terminal filament.

Fig. 12. A young tentillum with involucre. Characters as in fig. 11.

Fig. 13. A young tentillum without involucre. Characters as in fig. 11.

Fig. 14. A single androphore; *hu*, umbrella; *hx*, spadix; *hc*, central canal; *hs*, spermarium.

Fig. 15. A single gynophore. *fp*, Pedicle; *cp*, its canal; *fu*, umbrella; *xm*, network of spadicine canals; *o*, ovule; o^1, germinal spot; o^2, germinal vesicle; o^3, germinal yolk.

ANTHEMODES ORDINATA

PLATE XVI.

Order PHYSONECTÆ.

Family AGALMIDÆ.

Lychnagalma vesicularia.

PLATE XVI.

Drawn by me from life in Ceylon, December 1881.

Lychnagalma vesicularia, n. sp. (p. 253).

Fig. 1. The complete corm in a living state, quietly floating on the surface, with expanded stem and tentacles. The biserial nectosome is composed of a small apical pneumatophore (*p*), and ten pairs of opposite nectophores (*n*). The long siphosome (the lower part of which is truncated) is densely covered with bracts and bears numerous loose cormidia. The hydrostatic terminal ampullæ of the tentilla are directed upwards.

Fig. 2. The same corm, half dead, in a highly contracted state, after the detachment of most of the appendages; slightly magnified. *a*, Trunk; *i*, buds of nectophores; *p*, pneumatophore; *b*, bracts; *s*, siphons; *q*, palpons; *t*, tentacles.

Fig. 3. A portion of the siphosome; slightly magnified. *a*, Trunk; *b*, bracts; *sm*, siphons; *ss*, suctorial disc of the mouth; *g*, gonodendra.

Fig. 4. Pneumatophore. *pp*, Pigment-cap (mitra ocellaris); *py*, pylorus infundibuli; *pq*, radial pouches of the pericystic cavity; *pr*, radial septa between them; *i*, buds of nectophores; *a*, trunk.

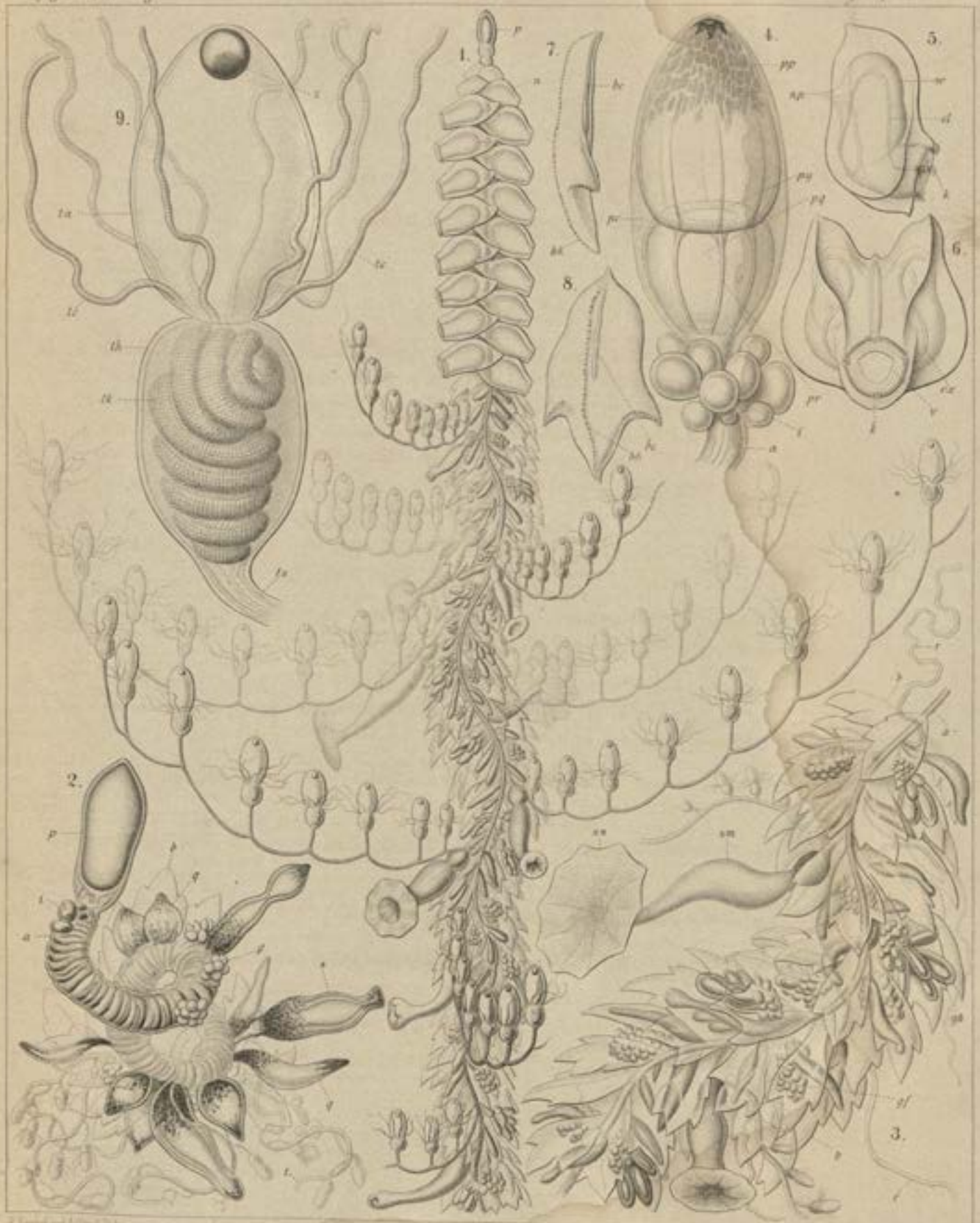
Fig. 5. Lateral view of a nectophore (from the left side). *np*, Pedicle; *cl*, left radial canal; *w*, subumbrella.

Fig. 6. Dorsal view of a nectophore. *v*, Velum; *k*, four cnidonodes on its basal insertion (rudimentary tentacles).

Fig. 7. Lateral view of a bract (in profile). *bc*, Bracteal canal.

Fig. 8. Dorsal view of a bract (from above). *bc*, Bracteal canal.

Fig. 9. A single tentillum. *ts*, Pedicle; *th*, involucre; *tk*, cnidoband; *ta*, hydrostatic terminal ampulla; *x*, oil-globule in its apex; *tc*, corona of eight (contracted) radial filaments around its base.



LYCHNAGALMA VESICULARIA.

PLATE XVII.

Order PHYSONECTÆ.

Family AGALMIDÆ.

Crystallodes vitrea.

PLATE XVII.

Drawn from life by me in Ceylon, in January 1882.

Crystallodes vitrea, n. sp. (p. 222).

Diam.

Fig. 1. Lateral view of the complete corm (from the left side), whilst quietly floating on the surface, with horizontal trunk. The pneumatophore (*p*) is directed upwards. One series of nectophores (*n*) is dorsal, the opposite ventral. Five cormidia depend in the ventral median line of the siphosome, which is entirely covered with bracts (*b*), . × 2

Fig. 2. Dorsal view of the same corm. Characters as in fig. 1, . . × 2

Fig. 3. Ventral view of the same corm. Characters as in fig. 1, . . × 2

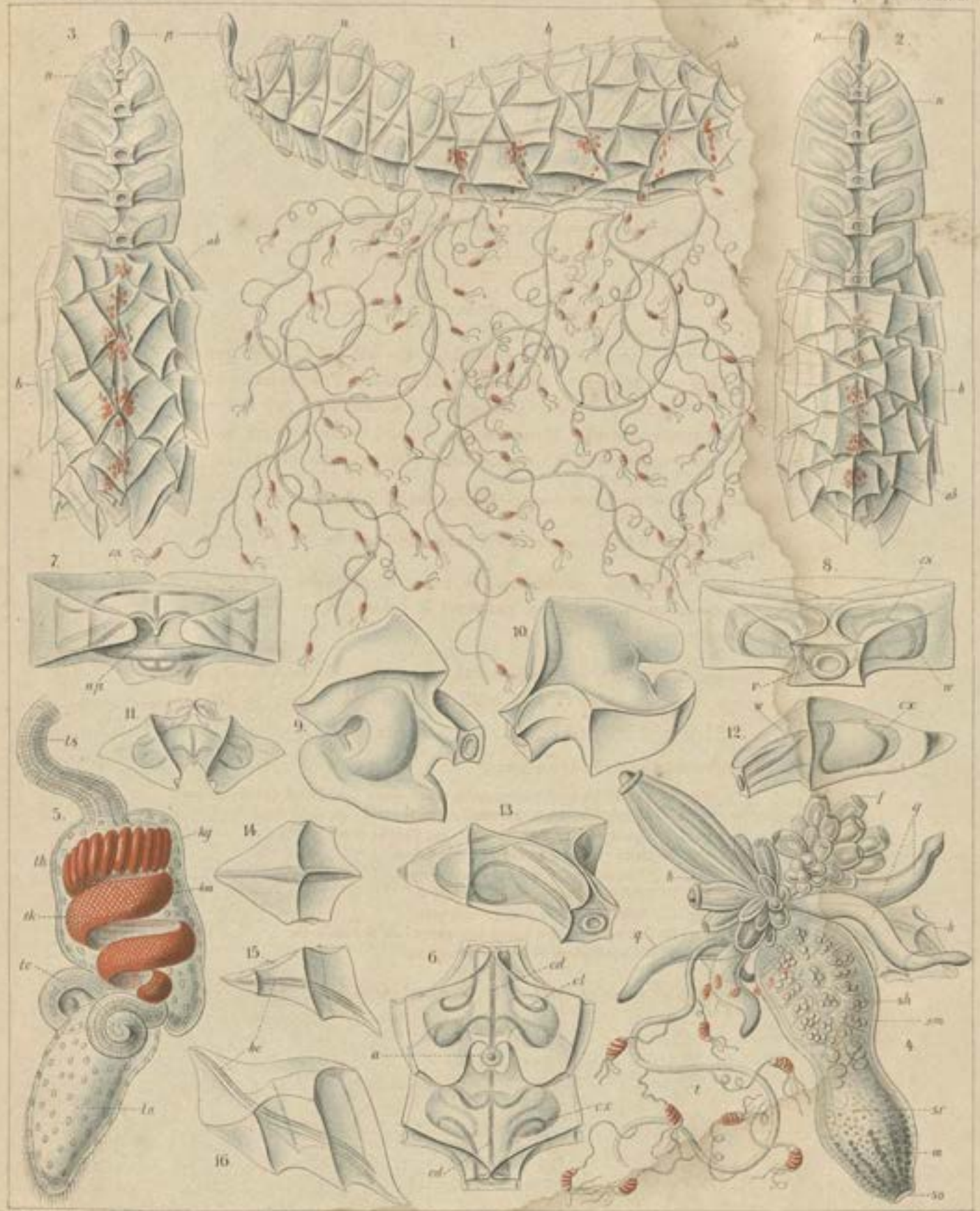
Fig. 4. A single cormidium. *sm*, Siphon; *sh*, liver; *sr*, proboscis; *m*, muscles; *so*, mouth; *t*, tentacles; *q*, palpons; *b*, bracts; *h*, androphores; *f*, gynophores, ... × 20

Fig. 5. A single tentillum. *ts*, Pedicle; *th*, involucre; *tk*, cnidoband; *kg*, large basal cnidocysts; *km*, small paliform cnidocysts; *tc*, lateral horns; *ta*, terminal ampulla, ... × 200

Figs. 6–13. Different views of nectophores, ... × 4

Fig. 6. Dorsal view of two opposite nectophores. *a*, Trunk (in transverse section); *cd*, dorsal canal; *cl*, left canal; *cx*, right canal.
Fig. 7. Apical view of a nectophore. *np*, Pedicle of insertion.
Fig. 8. Basal view of a nectophore. *v*, Velum.
Fig. 9. Oblique ventral view of a nectophore.
Fig. 10. Oblique dorsal view of a nectophore.
Fig. 11. Apical view of a young nectophore.
Fig. 12. Lateral view of a young nectophore. *w*, Subumbrella.
Fig. 13. Oblique lateral view of a nectophore.

Figs. 14–16. Different views of bracts. *bc*, Bracteal canal, . . × 4



CRYSTALLODES VITREA.

PLATE XVIII.

Order PHYSONECTÆ.

Families APOLEMIDÆ et AGALMIDÆ.

Figs. 1–7. *Dicymba diphyopsis.*
Figs. 8–17. *Agalma eschscholtzii.*

PLATE XVIII.

Figs. 1–7. *Dicymba diphyopsis* (p. 210).

Fig. 1. The entire corm, drawn from life, with expanded trunk, and twelve fully developed ordinate cormidia. *p*, Pneumatophore; *n*, nectophores; *w*, subumbrella; *v*, velum; *a*, axial trunk.

Fig. 2. A single cormidium. *s*, Siphon; *sh*, its four hepatic ridges; *sr*, proboscis; *sb*, basigaster; *t*, tentacle; *y*, cyston; *q*, palpons; *r*, palpacles; *b*, bracts; *h*, androphores; *f*, gynophores; *a*, trunk of the corm.

Fig. 3. A female gonodendron.

Fig. 4. A single female gonophore. *fu*, Umbrella; *o*, ovarium with a single egg, surrounded by a network of spadicine canals (*cy*); *uy*, ocelli of the margin; *cr*, radial canals.

Fig. 5. A male gonodendron.

Fig. 6. A single male gonophore. *hu*, Umbrella; *hm*, spermarium; *cr*, radial canals.

Fig. 7. Transverse section through the trunk. *at*, Axial canal of the trunk; *d*, entoderm; *m*, longitudinal muscles; *e*, exoderm; *i*, bud in the ventral median line; *ad*, nerve in the dorsal median line.

Figs. 8–17. *Agalma eschscholtzii*, n. sp. (p. 226).

Fig. 8. The entire corm, drawn from life. The nectosome is composed of an apical pneumatophore (*p*) and four pairs of nectophores (*n*). The subspherical siphosome is densely covered with bracts (*b*); from its axial cavity issue below a number of siphons (*s*) and tentacles, palpons (*q*) and palpacles (*r*).

Fig. 9. A single nectophore, from the dorsal side. *w*, Subumbrella; *uy*, ocelli.

Fig. 10. A trilobate bract, from the dorsal side. *bc*, Bracteal canal.

Fig. 11. A quinquelobate bract, from the dorsal side.

Fig. 12. A trilobate bract, in profile.

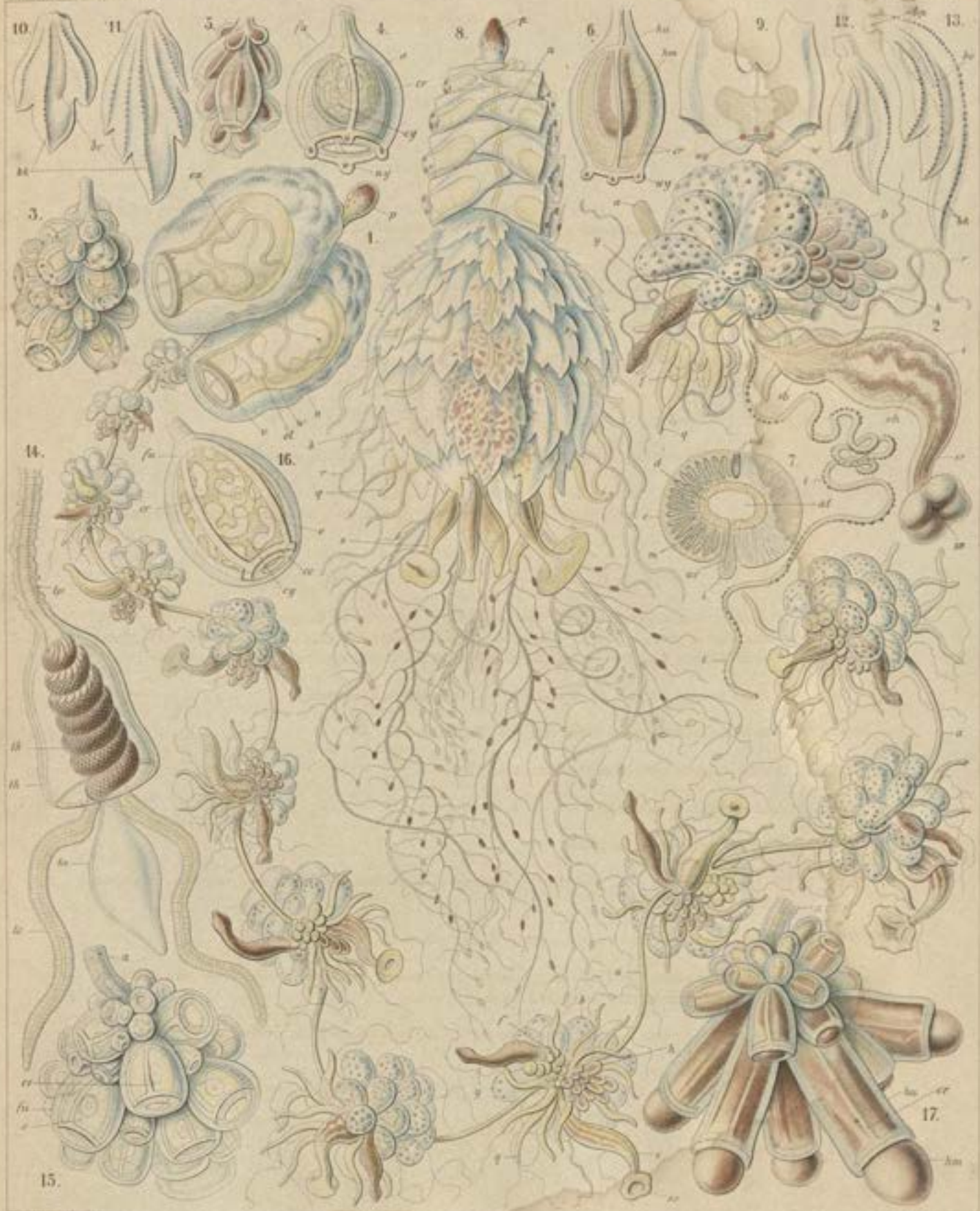
Fig. 13. A quinquelobate bract, in profile.

Fig. 14. A single tentillum. *tp*, Pedicle; *th*, involucre; *tk*, cnidoband; *ta*, terminal ampulla; *tc*, paired lateral horns.

Fig. 15. A female gonodendron. *fu*, Umbrella of the gynophores; *o*, egg; *a*, trunk.

Fig. 16. A single gynophore. *fu*, Umbrella; *cr*, its four radial canals; *cc*, circular canal; *cy*, spadicine canals of the manubrium (around the egg); *o*, ovule.

Fig. 17. A male gonodendron. *a*, Trunk; *hu*, umbrella of the androphores; *hm*, spermarium.



1-7. DICYMBA DIPHYOPSIS. 8-17. AGALMA ESCHHOLTZII.

PLATE XIX.

Order PHYSONECTÆ.

Family DISCOLABIDÆ.

Discolabe quadrigata.

PLATE XIX.

Figs. 1–4 were drawn by me from life in Ceylon, in December 1881.

Discolabe quadrigata, n. sp. (p. 263).

Diam.

Fig. 1. The complete corm, living and floating quietly on the surface of the sea. *p*, Pneumatophore; *n*, nectophores; *q*, palpons; *r*, palpacles; *s*, siphons; *t*, tentacles; *g*, gonodendra, ... × 2

Fig. 2. Lateral view of a nectophore, from the right side. *np*, Pedicle; *cx*, right radial canal; *cc*, ring-canal, ... × 5

Fig. 3. Dorsal view of a nectophore. *cl*, Left canal; *cx*, right canal; *no*, ostium of the nectosac, ... × 5

Fig. 4. Basal view of a nectophore, from the outside. *np*, Pedicle on the ventral side; *cc*, ring-canal, ... × 5

Figs. 5–8. Different larval stages (*Physonula*). Compare pp. 261, 262.

Fig. 5. A young medusiform larva, with incipient tentacle (*t*). *b*, Umbrella (or bract); *p*, pneumatophore (pneumadenia of the umbrella); *s*, siphon; *so*, mouth.

Fig. 6. A somewhat older larva, with sessile cnidonodes on the tentacle (*t*). Characters as in fig. 5. *x*, Cnidonode on the distal end of the pedicular canal; *bc*, bracteal canal; *q*, palpons.

Fig. 7. An older larva, with pediculate tentilla on the tentacle (*t*). Characters as in figs. 5 and 6.

Fig. 8. *Physonula* with two opposite primary nectophores (*n*), similar to *Dicymba* (Pl. XVIII. fig. 1). The pedicle (*am*) of the single siphon (*s*) represents the trunk of the incipient polygastric corm. Characters as in figs. 5–7.

DISCOLABE QUADRIGATA.

PLATE XX.

Order PHYSONECTÆ.

Family DISCOLABIDÆ.

Discolabe quadrigata.

PLATE XX.

Discolabe quadrigata, n. sp. (p. 263).

Figs. 9–13. Different views of the vesicular trunk, after detachment of the nectophores, palpons, siphons, and tentacles. *p*, Pneumatophore; *pp*, pigment-cap (mitra ocellaris); *pr*, radial septa between the eight pouches of the pericystic cavity; *an*, spindle-shaped trunk of the nectosome; *np*, convoluted longitudinal fold on its ventral median line, where the pedicles of the nectophores have been attached; *in*, buds of nectophores; *as*, discoidal trunk of the siphosome, spirally twisted in the form of a subcircular inflated bag; *af*, quadrangular facettes on the peripheral margin of the trunk of the siphosome, each facette corresponding to the insertion of a large palpon, and the small opening in its centre (*eq*) to the small canal which connects the cavities of the palpon and of the vesicular trunk. Attached to the inferior margin of each facette are two distylic clustered gonodendra; a larger proximal female cluster (*f*), composed of very numerous ovate gynophores; and a smaller distal male cluster (*h*) with a single large spindle-shaped gonopalpon (*gp*). The pedicles of the detached siphons are visible in the basal view (fig. 12, *sp*).

Fig. 9. Apical view of the trunk (from above).
Fig. 10. Lateral view of the trunk (from the left side).
Fig. 11. Ventral view of the trunk (from before).
Fig. 12. Basal view of the trunk (from below).
Fig. 13. Ventral view of a smaller trunk. A single siphon (*s*) and tentacle (*t*) have remained in this younger specimen attached to the stem.

Fig. 14. A single tentillum. *tp*, Distal portion of the inflated pedicle; *th*, vesicular involucre; *ty*, ocellus in its wall; *tk*, spiral cnidoband.

Fig. 15. Apical view of the nectosome, exhibiting the cruciform arrangement of the four rows of nectophores (*n*) around the central pneumatocyst (*p*).

Fig. 16. A single complete cormidium, in the usual natural position of its component organs. *q*, Palpon (horizontal); *af*, facette of the trunk where the proximal base of the palpon is inserted; *cp*, canal of the palpon in the centre of the facette; *r*, palpacle; *gf*, clustered female gonodendron; *gh*, smaller male gonodendron; *gq*, its large gonopalpon; *hp*, insertions of pedicles of detached androphores; *s*, siphon (vertical); *so*, its distal mouth; *t*, tentacle; *ts*, tentilla; *ks*, cnidosacs.

DISCOLABE QUADRIGATA.

PLATE XXI.

Order PHYSONECTÆ.

Families CIRCALIDÆ et ATHORIDÆ.

Figs. 1–4. *Circalia stephanoma.*
Figs. 5–8. *Athoria larvalis.*
Figs. 9–13. *Larvæ Physonectarum.*

PLATE XXI.

Figs. 1–4. *Circalia stephanoma*, n. sp. (p. 198).

Fig. 1. The entire monogastric corm, drawn from life. *p*, Pneumatophore; *pf*, pneumatocyst; *pp*, pigment-cap; *pi*, pneumatochone; *n*, corona of eight nectophores; *v*, velum; *gh*, male gonodendron; *gf*, female gonodendron; *q*, palpons; *r*, palpacles; *t*, tentacle; *s*, siphon; *sh*, liver-ridges; *sr*, proboscis; *ss*, suctorial mouth.

Fig. 2. Apical view of the half corm. Characters as in fig. 1.

Fig. 3. Basal view of the half corm. *ss*, Suctorial mouth; *h*, androphores; *f*, gynophores.

Fig. 4. Horizontal section through the pneumatophore. *pf*, Cavity of the pneumatocyst; *pq*, radial pouches of the pneumatophore; *pr*, radial septa between the pouches.

Figs. 5–8. *Athoria larvalis*, n. sp. (p. 202).

Fig. 5. The entire monogastric corm, drawn from life. *p*, Pneumatophore; *b*, corona of bracts; *q*, palpons; *r*, palpacles; *t*, tentacle; *s*, siphon; *ss*, suctorial disc of the mouth.

Fig. 6. Vertical frontal section through the axis of the corm (semi-diagrammatic). *p*, Pneumatophore; *pf*, pneumatocyst; *pc*, pericystic cavity; *pi*, pneumatochone; *at*, cavity of the trunk; *b*, bracts; *bc*, bracteal canal; *bs*, rudimentary nectosac of the bract; *cr*, its radial canals; *k*, cnidonodes on its mouth; *q*, palpon; *r*, palpacle; *h*, androphores; *f*, gynophores; *t*, tentacle; *ts*, tentilla; *sb*, basi-gaster; *sm*, stomach; *sv*, its hepatic villi; *sr*, proboscis; *ss*, suctorial mouth.

Fig. 7. A single bract. *bc*, Bracteal canal; *bs*, subumbrella; *k*, cnidonodes on its mouth.

Fig. 8. A single tentillum. *ts*, Pedicle; *tk*, spiral cnidoband; *tf*, terminal filament.

Figs. 9–13. *Larvæ Physonectarum* (pp. 195, 200).

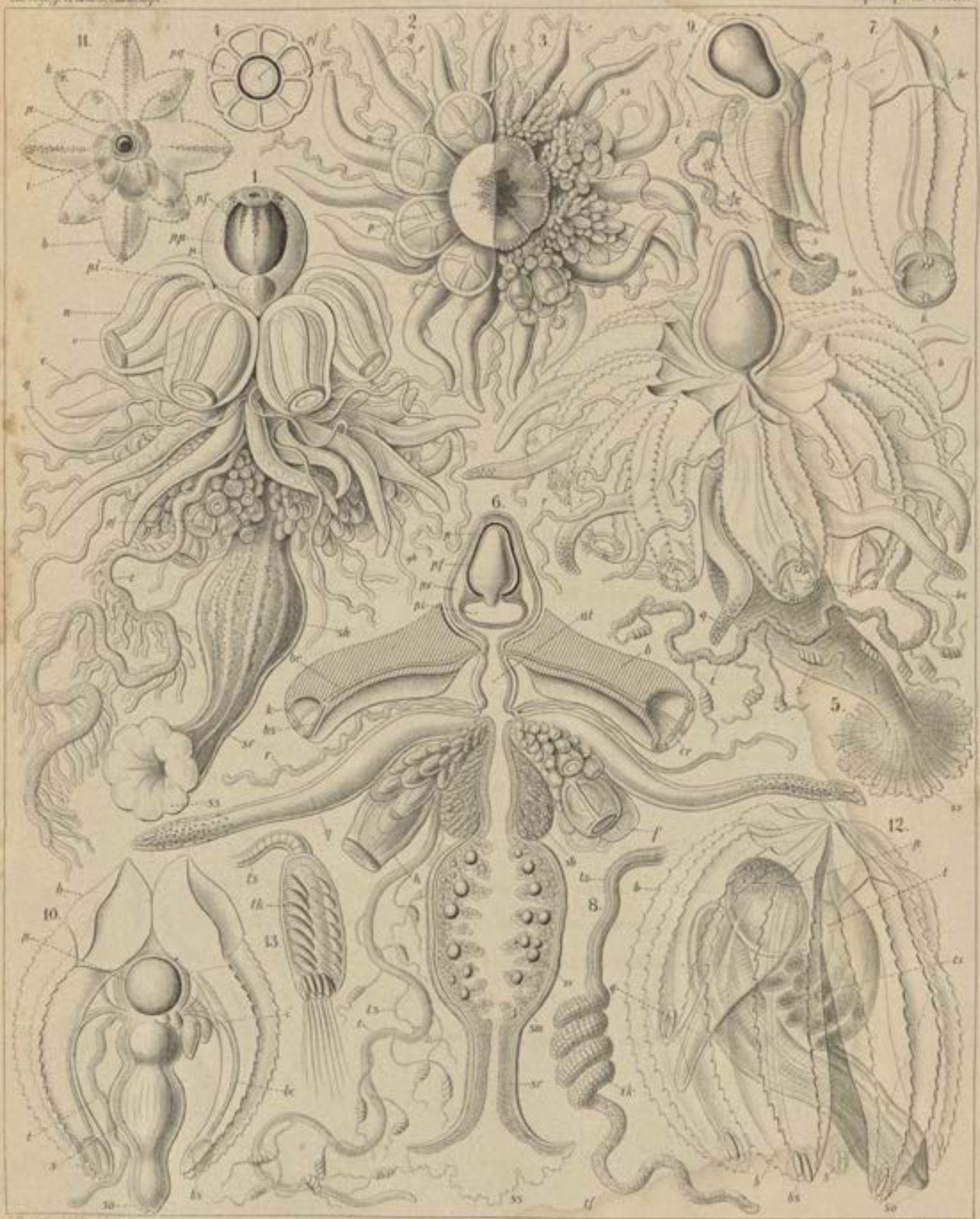
Fig. 9. Larva with a single bract (*b*). *p*, Pneumatophore; *s*, siphon; *so*, mouth; *t*, tentacle; *i*, buds.

Fig. 10. Larva with two opposite five-edged bracts (*b*). Characters as in fig. 9. *bs*, Nectosac.

Fig. 11. Larva with four cruciate trifid bracts (*b*) seen from the apex. *p*, Pneumatophore; *i*, buds; *k*, cnidonodes.

Fig. 12. Larva with a corona of five-edged bracts (*b*). Characters as in figs. 9, 10.

Fig. 13. Rudimentary tentillum. *ts*, Pedicle; *tk*, cnidosacs.



1-4 CIRCALIA STEPHANOMA. 5-13 ATHORIA LARVALIS

PLATE XXII.

Order CYSTONECTÆ.

Families CYSTALIDÆ et EPIBULIDÆ.

Figs. 1–5. *Cystalia monogastrica.*
Figs. 6–8. *Epibulia ritteriana.*

PLATE XXII.

The figures of this Plate were drawn by me from life in Ceylon, in December 1881 and January 1882.

Figs. 1–5. *Cystalia monogastrica*, n. sp. (p. 316).

Fig. 1. Larva of an early stage, near to the gastrula. The spindle-shaped body is composed of a small-celled ciliated exoderm (*e*) and a large-celled entoderm (*d*). The incipient pneumatophore (*p*) is a simple invagination of the apical pole.

Fig. 2. Larva of a second stage. The medusiform body is divided by a transverse constriction into an apical and a basal half; the former includes the pneumatophore (containing an air-bubble), and is homologous with the umbrella; the latter includes the gastral cavity (*sc*), and is the primary siphon. From the constriction arises a simple tentacle (*t*). The distal end of the siphon has a mouth-opening (*so*). *ps*, Pneumatosac; *pf*, pneumatocyst.

Fig. 3. Larva of a third stage, differing from the preceding (fig. 2) in the formation of a bud (palpon), which arises from the ventral side of the transverse constriction (*i*), opposite to the dorsal tentacle (*t*). Characters as in figs. 1, 2.

Fig. 4. Larva of a fourth stage. A corona of buds (palpons) arises from the base of the siphon below the float. The tentacle (*t*) bears a series of simple filiform tentilla (*ts*).

Fig. 5. A mature corm of *Cystalia monogastrica*, representing a single cormidium. *p*, Pneumatophore; *pf*, pneumatocyst filled with air; *pi*, pneumatochone; *q*, palpons; *sb*, basigaster; *sh*, hepatic villi of the stomach; *sr*, proboscis; *ss*, mouth; *t*, tentacle; *gd*, monostylic gonodendron.

Figs. 6–8. *Epibulia ritteriana*, n. sp. (p. 335).

Fig. 6. A mature corm of *Epibulia ritteriana*. *p*, Pneumatophore (compare the sections in figs. 7 and 8); *q*, palpons; *qo*, ocelli; *s*, siphons; *sh*, hepatic villi; *ss*, mouth; *t*, tentacles; *ts*, tentilla; *gd*, gonodendra.

Fig. 7. Vertical section through the axis of the pneumatophore. *po*, Apical ostium; *pu*, pneumatocodon; *ps*, pneumatosaccus; *pp*, pigment-cap (mitra ocellaris); *pf*, pneumatocyst; *py*, pylorus infundibuli; *pi*, infundibulum (pneumatochone); *pc*, pericystic cavity; *pd*, endocystic tapetum; *pv*, hypocystic villi; *at*, cavity of the trunk.

Fig. 8. Horizontal section through the pneumatophore. Characters as in fig. 7.

1–5. CYSTALIA MONOGASTRICA. 6–8. EPIBULIA RITTERIANA.

PLATE XXIII.

Order CYSTONECTÆ.

Family RHIZOPHYSIDÆ.

Nectophysa wyvillei.

PLATE XXIII.

The figures of this Plate were drawn by me from living specimens in the Canary Island Lanzerote, December 26, 1866.

Nectophysa wyvillei, n. sp. (p. 327).

Diam.

Fig. 1. A complete corm, in the expanded state, quietly floating on the surface. *p*, Pneumatophore; *po*, its apical stigma; *pv*, hypocystic villi; *a*, trunk; *s*, siphons; *t*, tentacles; *ga*, gonodendra, . . . nat. size

Fig. 2. A complete larger corm, in the expanded state, with twisted trunk, reposing on the bottom of the glass vessel. The suctorial mouth-discs of the lower siphons are attached to the wall of the vessel. Characters as in fig. 1, ... nat. size

Fig. 3. A complete corm (the same as fig. 1) in the contracted state, with shortened and thickened trunk, coiled up in a dexiotropic spiral. An air-bubble (*x*) is being expelled through the apical stigma (*po*) of the pneumatophore; *pf*, pneumatocyst; *pp*, pigment-cap (mitra ocellaris); *pv*, hypocystic villi, ... × 4

Fig. 4. Uppermost portion of the fully contracted trunk. The pneumatocyst (*pf*) is nearly evacuated and the greatest part of the gas expelled through the apical stigma (*po*). The hypocystic villi (*pv*) are thrown into the vesicular inflated apical portion of the trunk (*a*); *i*, buds; *ga*, gonodendra; *s*, siphons, ... × 10

Fig. 5. A single siphon, with its tentacle (*t*) attached to the trunk (*at*); *ts*, tentilla, ... × 20

Fig. 6. A small portion of a tentillum. *kc*, Cnidocysts; *tw*, palpoblasts, . × 300

Fig. 7. A single cnidocyst with the included cnidofilament, . . . × 900

Fig. 8. A single branch of a gonodendron. *gq*, Gonopalpon; *h*, androphores; *hx*, spadix; *hs*, sperma; *f*, gynophore; *fm*, its rudimentary manubrium; *uw*, subumbrellar cavity, ... × 50

NECTOPHYSA WYVILLEI

PLATE XXIV.

Order CYSTONECTÆ.

Family RHIZOPHYSIDÆ.

Cannophysa murrayana.

PLATE XXIV.

The figures of this Plate were drawn by me from living specimens in the Canary Island Lanzerote, January 7, 1867.

Cannophysa murrayana, n. sp. (p. 324).

Fig. 1. An adult corm, with large ripe gonodendra of a golden colour attached to the yellow trunk near the base of the rose-coloured siphons. The cylindrical trunk is twisted in a dexiotropic spiral. The apical pneumatocyst is rather expanded. The animal reposes quietly on the bottom of the glass vessel.

Fig. 2. The same corm, in the highly contracted state, seen from above. *p*, Pneumatocyst; *g*, gonodendron; *s*, siphon.

Fig. 3. A young corm, without gonodendra, in the expanded state. The rose-coloured siphons arise from the yellow trunk at equal distances. *a*, Trunk; *p*, pneumatophore; *s*, siphons; *t*, tentacles.

Fig. 4. The pneumatophore. *po*, Apical stigma; *pp*, pigment-cap (mitra ocellaris); *pf*, pneumatocyst filled with gas; *pd*, tapetum endocystalé; *pv*, hypocystic villi; *i*, buds; *s*, siphons.

Fig. 5. Oblique apical view of the same pneumatophore. *po*, Apical stigma, open; *pp*, mitra ocellaris; *pm*, radial fibres of the muscular dilatator; *pn*, circular fibres of the muscular sphincter; *pz*, hypocystic villi; *p*, pneumatocodon.

Fig. 6. A group of hypocystic villi. Each villus consists of a few gigantic exoderm cells and a covering epithelium of numerous small ciliated entoderm cells (*pz*).

Fig. 7. Three greenish exoderm cells of the pneumadenia, taken from the endocystic tapetum.

Fig. 8. A single tentacle, arising from the base of the siphon (*s*). *ts*, Tentilla; *te*, simple terminal appendage of the tentacle (without tentilla); *a*, stem.

Fig. 9. A single tentillum. *ts*, Villi of the pedicle; *ta*, terminal ampulla; *tf*, its distal appendage; *tc*, lateral horns.

CANNOPHYSA MURRAYANA.

PLATE XXV.

Order CYSTONECTÆ.

Family SALACIDÆ.

Salacia polygastrica.

PLATE XXV.

Salacia polygastrica, n. sp. (p. 331).

Diam.

Fig. 1. A complete corm. The large ovate pneumatophore exhibits the enclosed pneumatocyst and the hypocystic villi. The long tubular trunk bears a series of numerous ordinate polygastric cormidia, separated by free naked internodes, ... × 4

Fig. 2. Transverse section through the pneumatophore in the equatorial plane. *pi*, Pneumatochone (infundibulum pneumaticum); *py*, pylorus infundibuli; *pv*, hypocystic villi; *pu*, pneumatocodon (umbrella pneumatica), ... × 8

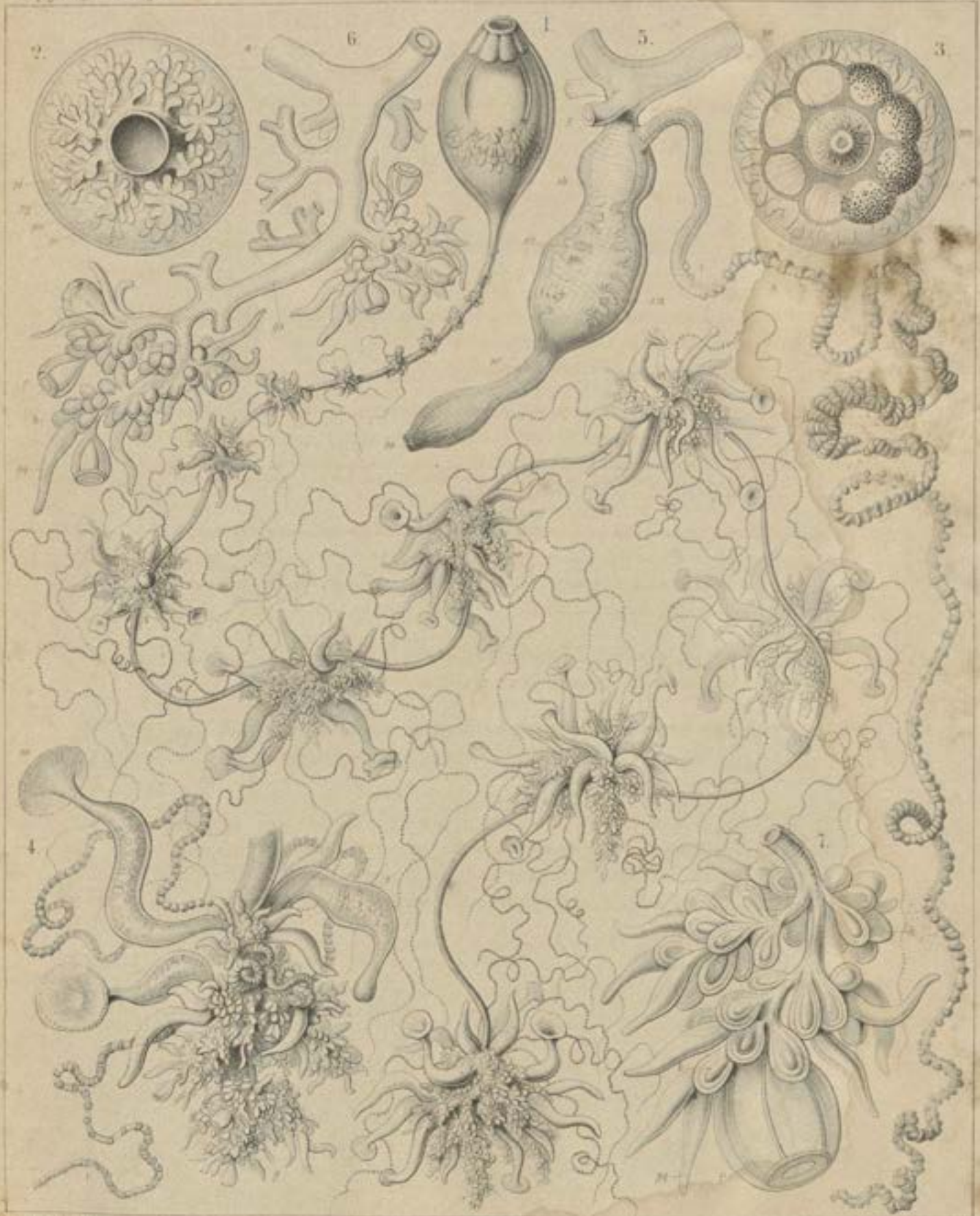
Fig. 3. Apical view of the pneumatophore (from above). *po*, Central stigma (apical ostium); *pm*, radial muscles (dilatator stigmatis), round which is seen the mitra ocellaris (corona of eight radial pigment-lobes); *pv*, hypocystic villi, ... × 8

Fig. 4. A single (polygastric and monoclinic) cormidium, attached to the stem. *s*, Siphons; *so*, suctorial disc; *t*, tentacle; *g*, gonodendron, . . × 8

Fig. 5. A single siphon with its tentacle (*t*) attached to the trunk. *g*, Gonostyle; *sb*, basigaster; *sm*, stomach; *sv*, hepatic villi; *sr*, proboscis; *so*, mouth, ... × 20

Fig. 6. A single (monostylic) gonodendron, attached to the stem (*a*) and exhibiting the ramification of the gonostyle (*gs*). The majority of the numerous branches and gonophores have been removed. *f*, Gynophores; *h*, androphores; *gq*, gonopalpons, . . . × 20

Fig. 7. A single branch of the (monostylic) gonodendron. Characters as in fig. 6, ... × 50



SALACIA POLYGASTRICA.

PLATE XXVI.

Order CYSTONECTÆ.

Family PHYSALIDÆ.

Figs. 1–3. *Alophota giltschiana.*
Figs. 4–8. *Arethusa challengeri.*

PLATE XXVI.

The figures of this Plate were painted by me from living specimens in the Canary Island Lanzerote, December 1866.

Figs. 1–3. *Alophota giltschiana*, n. sp. (p. 348).

Diam.

Fig. 1. A young larva (*Cystonula*) 2 to 4 mm. in length. The complete body represents a single medusome, the modified umbrella of which is the pneumatophore (*pf*), the manubrium is the siphon (*s*). From the pedicle of the siphon (or the incipient trunk, *a*) arises a tentacle (*t*). The inside of the siphon bears hepatic villi (*sv*), and its terminal mouth forms a square suctorial disc (*ss*). The apex of the float opens by a stigma (*po*), ... × 20

Fig. 2. An older larva 8 mm. in length. The trunk (*a*) of the small corm encloses an ovate pneumatosac (*pf*) in its apical half, and bears the primary siphon (or protosiphon, *sv*) on the distal pole of the sub-horizontal main axis. From the middle third of its ventral side arise three small cormidia, each of which is composed of a secondary siphon, a palpon, and a tentacle; *po*, apical stigma, ... × 8

Fig. 3. A mature corm of *Alophota giltschiana*, seen from the right side. The pneumatocyst (*pf*) fills the greatest part of the vesicular trunk. *po*, The apical stigma (on the anterior end). The basal (or posterior) end of the trunk bears the primary siphon (*su*) with a palpon and a tentacle; *so*, mouth of siphon. The ventral side of the trunk bears an ordinate series of five cormidia, each composed of a secondary siphon (*s*), a palpon (*to*), a tentacle (*t*), and a gonodendron (*g*), ... × 4

Figs. 4–8. *Arethusa challengeri*, n. sp. (p. 349).

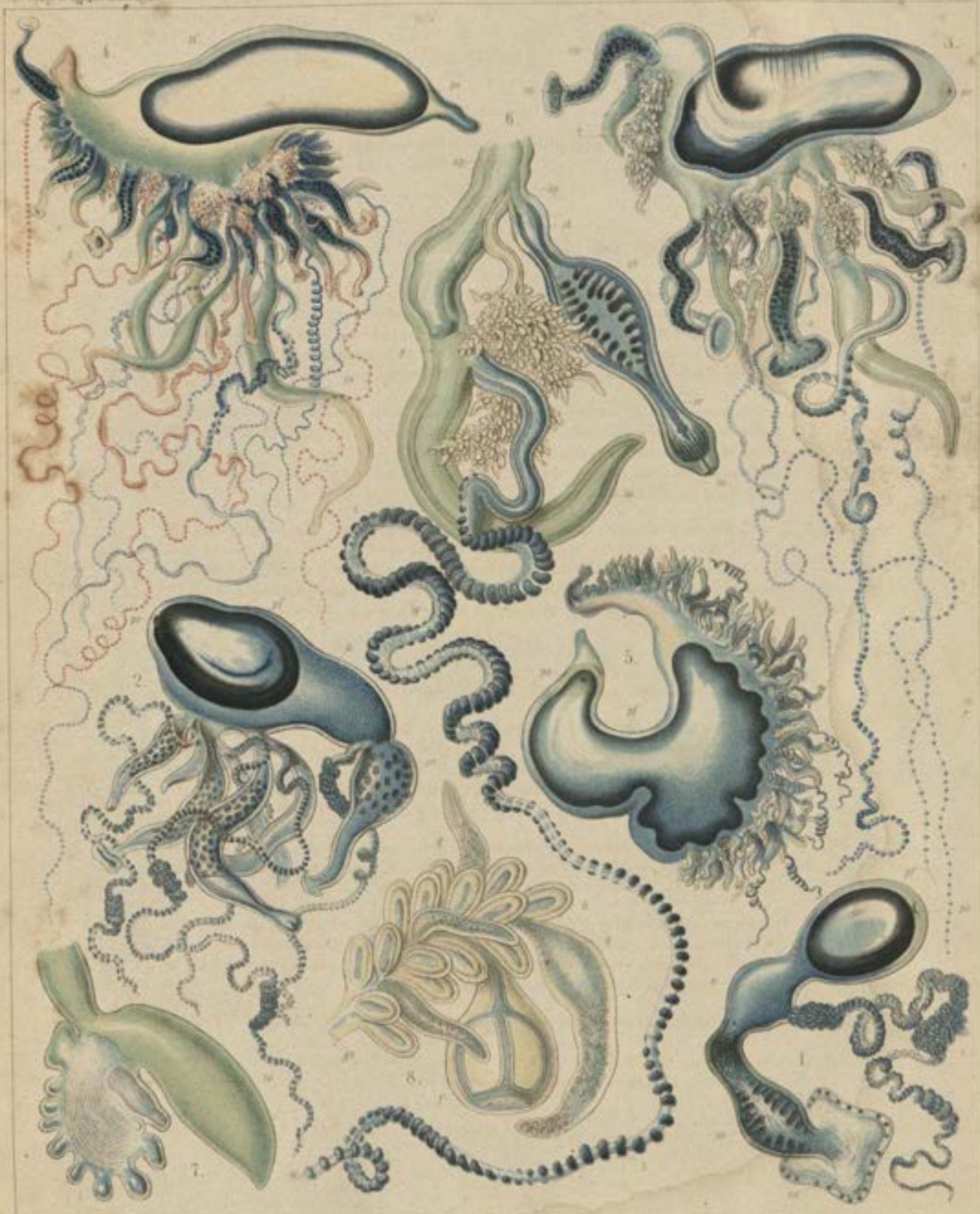
Fig. 4. Lateral view of a mature corm, from the right side. The oblongish pneumatosac (*pf*) fills only two-thirds of the vesicular trunk. *po*, Apical stigma. The sterile protosiphon (*su*), at the basal or distal pole of the horizontal axis, is separated by a group of small palpons from the ventral series of fertile metasiphons (*s*); the larger of these bear on the right side a rose-coloured gonodendron (*g*), ... × 2

Fig. 5. Lateral view of a larger corm, in a much contracted state, from the left side. The pneumatosac (*pf*) strongly contracted, with an annular constriction, expels gas through the apical stigma (*po*). The numerous tentacles are spirally coiled up, ... nat. size

Fig. 6. A single cormidium, isolated. The simple common pedicle (*ap*), arising from the ventral side of the trunk, bears a large tentacle (*t*), with a basal ampulla (*to*), a clustered gonodendron (*g*), and a contracted siphon with four segments; *sp*, siphonal pedicle; *sb*, basigaster, *sv*, stomach with black hepatic villi; *sr*, proboscis; *so*, mouth, ... × 10

Fig. 7. A very young tentacle (*t*) with its basal ampulla (*to*), ... × 40

Fig. 8. A single branch of a gonodendron. *gs*, Gonostyle; *q*, gonopalpons; *h*, androphores (male medusomes); *f*, gynophore (female medusome), ... × 20



ALOPHOTA GILTSCHIANA.

PLATE XXVII.

Order CALYCONECTÆ.

Family MONOPHYIDÆ.

Figs. 1–12. *Cymbonectes huxleyi.*
Figs. 13, 14. *Monophyes princeps.*

PLATE XXVII.

Figs. 1–12 of this Plate were drawn by me from life in Ceylon, in December 1881.

Figs. 1–12. *Cymbonectes huxleyi*, n. sp. (p. 134).

Diam.

Fig. 1. The entire corm with expanded stem. From the hydrœcial groove of the single nectophore proceeds a long tubular stem, which bears eight or nine well-developed diclinic cormidia, alternating males and females. The signification of the characters is the same as in figs. 2–4, ... × 10

Fig. 2. Dorsal view of the nectophore. *cs*, Somatocyst; *co*, oleocyst; *cx*, right canal; *cl*, left canal; *w*, subumbrella; *nd*, dorsal edge of the umbrella, ... × 10

Fig. 3. Ventral view of the nectophore. *a*, Apical part of the trunk; *nx*, right wing, *nl*, left wing of the ventral side of the exumbrella, protecting the hydrœcial canal, . . . × 10

Fig. 4. Horizontal transverse section through the middle part of the nectophore. *w*, Subumbrella; *ww*, its cavity; *cd*, dorsal canal; *cx*, right canal; *nd*, dorsal edge of the exumbrella; *nx*, right ventral wing; *nl*, left ventral wing; *ai*, hydrœcial canal; *a*, trunk of the siphosome, ... × 10

Fig. 5. A single female cormidium. *b*, Bract; *bc*, phyllocyst; *co*, oleocyst; *a*, trunk; *s*, siphon; *sb*, basigaster; *sm*, stomach; *sr*, proboscis; *ss*, suctorial disc; *f*, gynophore; *cr*, its radial canals; *o*, ovarium, ... × 50

Fig. 6. A single male cormidium. *b*, Bract; *bc*, phyllocyst; *co*, oleocyst; *a*, trunk; *s*, siphon; *t*, tentacle; *h*, androphore; *hx*, spadix; *hs*, spermarium; *uo*, ostium umbrellæ, . . × 50

Fig. 7. Longitudinal section through a single siphon, in a highly contracted state, with the neighbouring parts. *bc*, Phyllocyst; *co*, oleocyst; *t*, tentacle; *ts*, tentilla; *sb*, basigaster; *sm*, stomach; *sr*, proboscis; *so*, mouth, ... × 200

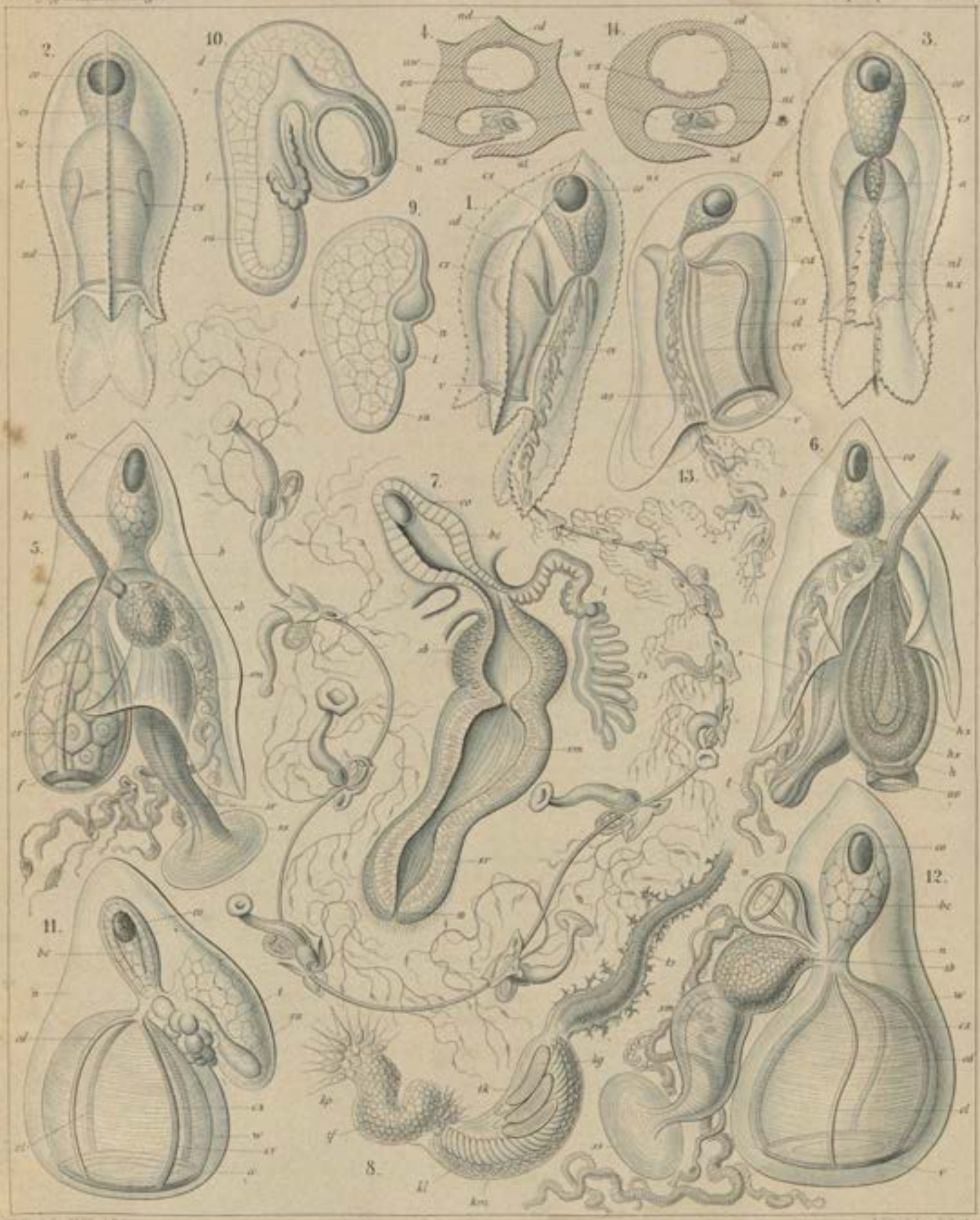
Fig. 8. A single tentillum. *ts*, Pedicle; *tk*, cnidosac; *kg*, large reniform lateral cnidocysts; *km*, small paliform median cnidocysts; *kp*, small pyriform distal cnidocysts; *tf*, terminal filament, ... × 400

Figs. 9–12. Four different larval stages (*Calyconula*) of *Cymbonectes huxleyi*, arising from the fertilized egg. Each larva is a single medusome, the manubrium of which (or the primary siphon, *s*) has been protruded through the ventral fissure of the umbrella (or the primary nectophore, *n*). *e*, Exoderm; *d*, entoderm; *t*, tentacle; *w*, subumbrella; *v*, velum, . × 300

Figs. 13, 14. *Monophyes princeps*, n. sp. (p. 129).

Fig. 13. Lateral view of the nectophore, from the left side. *cs*, Somatocyst; *co*, oleocyst; *cd*, dorsal canal; *cl*, left canal; *cx*, right canal; *cv*, ventral canal; *v*, velum; *as*, trunk, . . × 12

Fig. 14. Horizontal transverse section through the middle part of the nectophore. Characters as in fig. 4, ... × 12



1-12. CYMBONECTES HUXLEYI. 13-14. MONOPHYES PRINCEPS.

PLATE XXVIII.

Order CALYCONECTÆ.

Family MONOPHYIDÆ.

Mitrophyes peltifera.

PLATE XXVIII.

Drawn from life by me in the Canary Island Lanzerote, in January 1867.

Mitrophyes peltifera, n. sp. (p. 131).

Diam.

Fig. 1. The complete corm, with expanded stem; the apical bract (*b*) and the nectophore half in dorsal, half in lateral view (from the right side). *cv*, Ventral canal; *cd*, dorsal canal; *cx*, right canal; *cb*, bracteal canal; *v*, velum. The trunk of the dicecious siphosome is fully expanded and bears numerous ordinate cormidia, . . × 10

Fig. 2. The same corm, with contracted siphosome (*a*); the apical bract (*b*) is reflected to show its pedicle and the union with the nectophore (*n*). Characters as in fig. 1. *ab*, Cormidia, ... × 10

Fig. 3. A single female cormidium. *a*, Trunk; *b*, bract; *s*, siphon; *sm*, stomach; *sr*, proboscis; *so*, mouth; *kc*, cnidocysts; *t*, tentacle; *f*, gynophore; *o*, eggs; *v*, velum; *w*, subumbrella, ... × 100

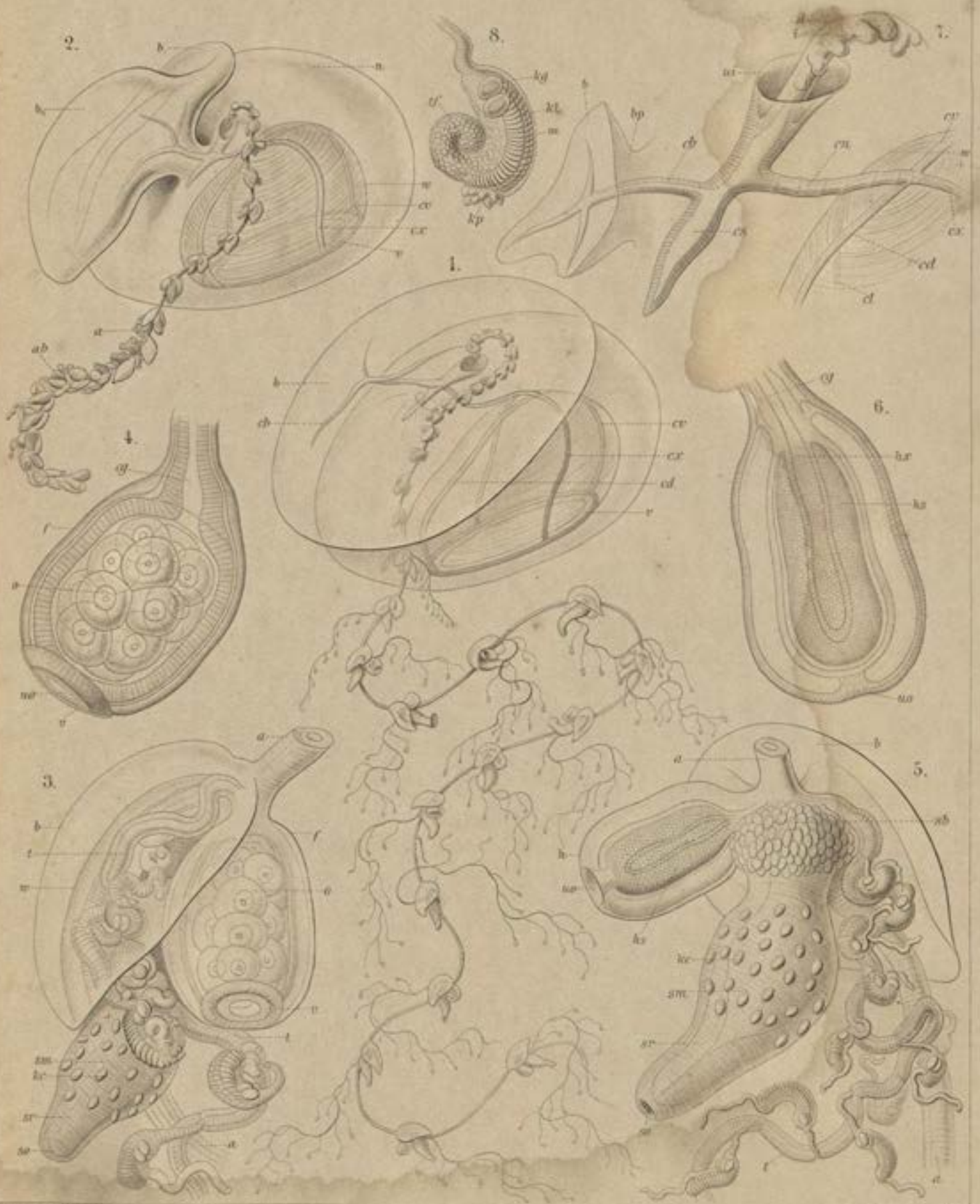
Fig. 4. A gynophore, with the included ovarium, isolated. *o*, Eggs; *uo*, ostium umbrellæ; *v*, velum, ... × 150

Fig. 5. A single male cormidium. Characters as in fig. 3. *h*, Androphore; *uo*, ostium of the umbrella; *sb*, basigaster, ... × 100

Fig. 6. An androphore, with the included spermarium, isolated. *hx*, Axial spadix; *hs*, sperma; *uo*, ostium umbrellæ, . . . × 150

Fig. 7. Apical portion of the trunk, with the connection of the apical bract (*b*) and the nectophore. *bp*, Pedicle of the bract; *cb*, bracteal duct; *cs*, somatocyst; *ui*, rudimentary hydrœcium; *a*, trunk; *i*, buds of cormidia; *cn*, nectophoral duct; *cv*, ventral canal; *cd*, dorsal canal; *cx*, right canal; *cl*, left canal. (Compare fig. 2), . . . × 40

Fig. 8. A single tentillum. *kg*, Large lateral cnidocysts; *m*, small median cnidocysts; *kp*, distal pyriform cnidocysts; *tf*, terminal filament, spirally coiled up, ... × 300



MITROPHYES PELTIFERA.

PLATE XXIX.

Order CALYCONECTÆ.

Family POLYPHYIDÆ.

Figs. 1–8. *Polyphyes ungulata.*
Figs. 9–14. *Vogtia köllikeri.*

PLATE XXIX.

Figs. 1–8. *Polyphyes ungulata*, n. sp. (p. 179).

Diam

Fig. 1. The complete corm. *an*, Trunk of the nectosome; *n*, nectophores; *s*, siphons; *ss*, suctorial mouth; *t*, tentacles; *h*, androphores; *f*, gynophores. (Lateral view of the nectosome), . . . × 4

Fig. 2. Lateral view of a nectophore (from the right side). *np*, Pedicle; *ce*, pallial canal; *w*, subumbrella, ... × 4

Fig. 3. Apical view of a nectophore. *np*, Pedicle; *nx*, right wing, *nl*, left wing, of the ventral groove; *ce*, pallial canal; *cc*, ring canal; *cv*, ventral canal; *cv''*, ventral sinus; *w*, subumbrella; *v*, velum, . × 4

Fig. 4. Basal view of a nectophore. Characters as in fig. 3, . . . × 4

Fig. 5. Basal view of two united nectophores. *an*, Trunk with buds, . . × 4

Fig. 6. Dorsal view of a nectophore, ... × 4

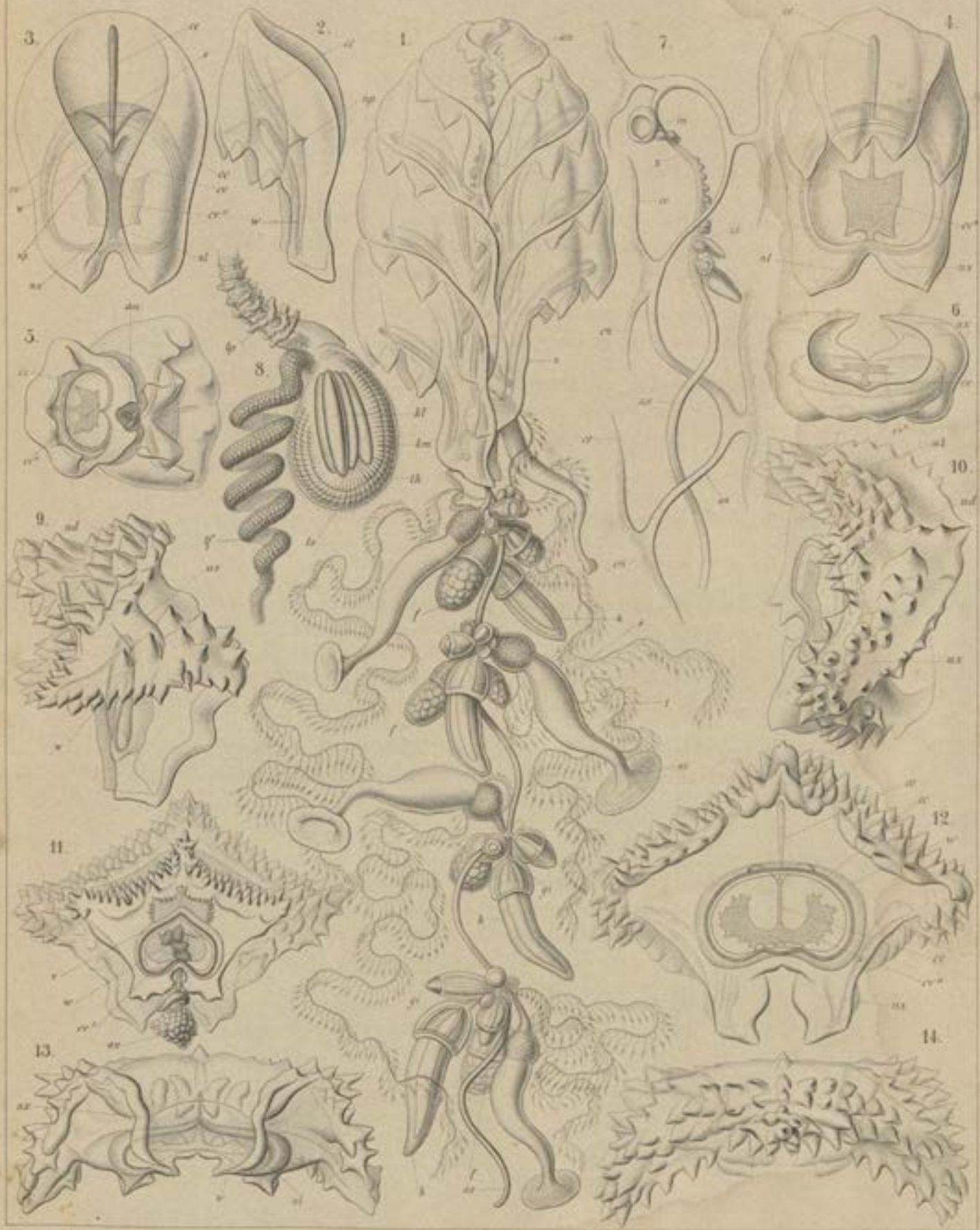
Fig. 7. The isolated trunk of the corm, after detachment of the appendages. *an*, Trunk of the nectosome; *in*, its blastocrene (buds of nectophores); *as*, trunk of the siphosome; *is*, its blastocrene (buds of siphons); *x*, free interval between the two blastocrenes (or points of vegetation); *cn*, canal of the nectophore; *ce*, its pallial canal, . . . × 4

Fig. 8. A single tentillum. *tp*, Pedicle; *ts*, cnidosac; *tk*, cnidotænia; *kl*, large lateral cnidocysts; *km*, small median cnidocysts; *tf*, terminal filament, × 200

Figs. 9–14. *Vogtia köllikeri*, n. sp. (p. 182), . . × 5

Figs. 9–14. Different views of nectophores. *ud*, Dorsal face of the umbrella; *ux*, right-hand face; *ul*, left-hand face; *nx*, right wing of the ventral groove; *nl*, left wing; *w*, subumbrella; *v*, velum; *ce*, pallial canal; *cc*, ring-canal; *cv*, ventral canal; *cv''*, ventral sinus.

Fig. 9. Lateral view (from the right side).
Fig. 10. Oblique lateral view (half dorsal, half right side).
Fig. 11. Basal view of a young nectophore; *an*, trunk with buds.
Fig. 12. Basal view of an adult nectophore.
Fig. 13. Ventral view.
Fig. 14. Dorsal view.



1-8. POLYPHYES UNGULATA. 9-14. VOGTIA KÖLLIKERI.

PLATE XXX.

Order CALYCONECTÆ.

Family DESMOPHYIDÆ.

Desmophyes annectens.

PLATE XXX.

Drawn by me from life in Ceylon, in December 1881.

Desmophyes annectens, n. sp. (p. 170).

Diam.

Fig. 1. The complete corm, with six nectophores and numerous diclinic cormidia, males and females alternating, ... × 3

Fig. 2. Lateral view of a single female cormidium (from the right side). *b*, Bract; *bc*, phyllocyst; *cv*, ventral canal; *cd*, dorsal canal; *cx*, right canal; *cl*, left canal (see fig. 3); *a*, trunk; *s*, siphon; *sr*, its proboscis; *t*, tentacle; *nn*, special nectophore; *w*, sub-umbrella; *v*, velum; *t*, rudimentary tentacles; *uy*, ocelli; *cc*, ring-canal; *cr*, radial canals; *f*, gynophore; *o*, eggs, . . . × 20

Fig. 3. Lateral view of a single male cormidium (from the left side); the special nectophore, and the bunch of androphores (represented in fig. 4), which fill up the ventral half of the bracteal cavity, have been detached. Characters as in fig. 2. *sb*, Basigaster; *sh*, hepatic ridges in the stomach; *sr*, proboscis; *ss*, suctorial disc, . . × 20

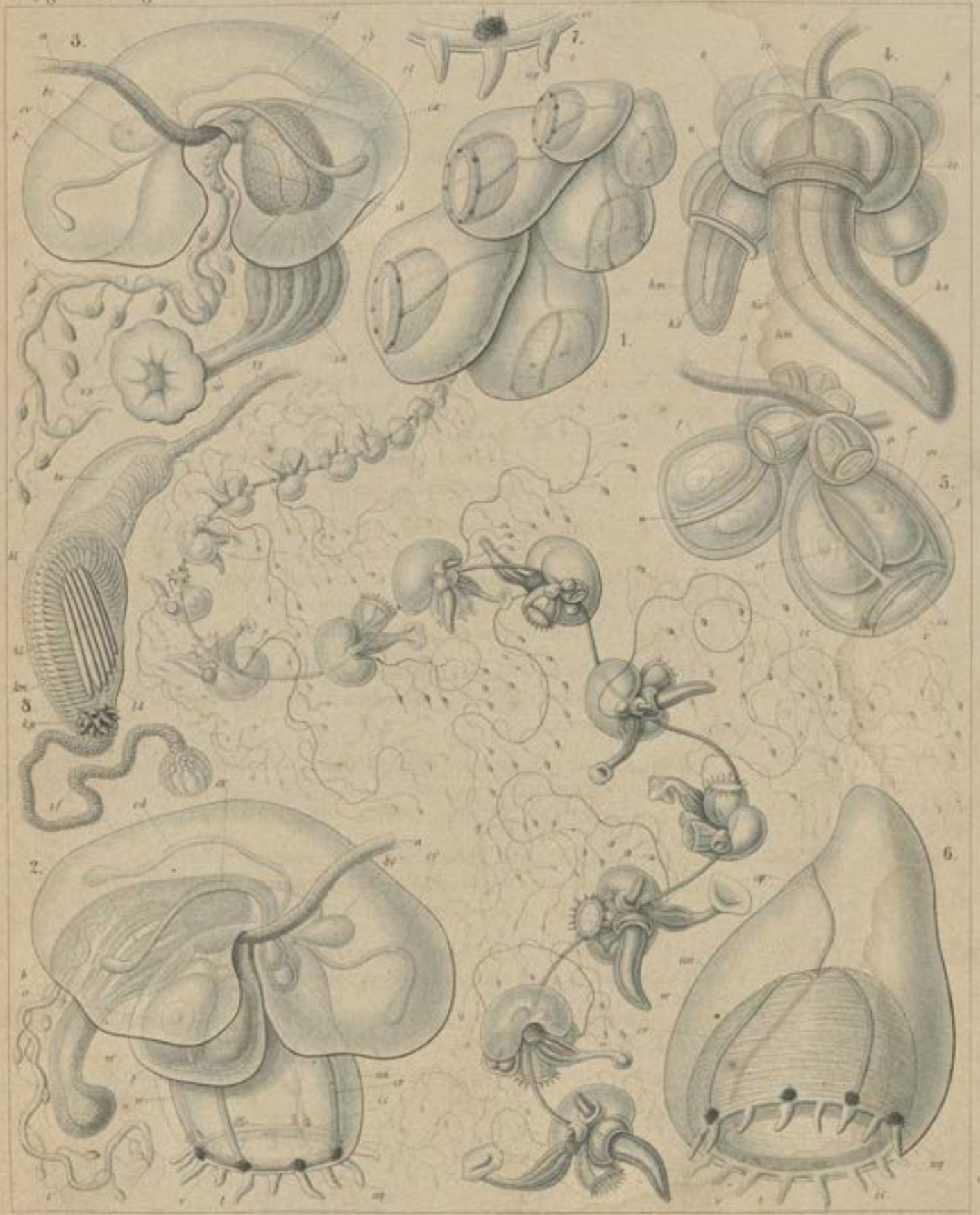
Fig. 4. A bunch of androphores (*h*) detached from the male cormidium, fig. 3. *u*, Umbrella; *cr*, its four radial canals; *cc*, ring-canal; *hm*, spermarium; *hx*, spadix; *hs*, sperma, ... × 40

Fig. 5. A bunch of gynophores (*f*) detached from a female cormidium. *u*, Umbrella; *cr*, its four radial canals; *v*, velum; *cc*, ring-canal; *o*, eggs; o^1, germinal spot; o^2, germinal vesicle; o^3, germinal yolk, . × 40

Fig. 6. A special nectophore, detached from a male cormidium. *w*, Sub-umbrella; *v*, velum; *t*, rudimentary tentacles; *uy*, ocelli; *cc*, ring-canal; *cr*, radial canals; *cp*, penduncular canal, . . . × 40

Fig. 7. A small portion of the umbrella margin of the special nectophore, fig. 6, more enlarged. *cc*, Ring-canal; *t*, rudimentary tentacles; *uy*, ocellus, × 100

Fig. 8. A single tentillum. *tt*, Pedicle; *to*, distal ampulla of the pedicle; *tk*, cnidosac; *kl*, large lateral cnidocysts; *km*, small median cnidocysts; *kp*, distal pyriform cnidocysts; *tf*, terminal filament, . . × 300



DESMOPHYES ANNECTENS.

PLATE XXXI.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Praya galea.

PLATE XXXI.

All the figures of this Plate were drawn by me from living specimens in the Canary Island Lanzerote, February 17–20, 1867.

The characters have the same signification in all the figures:—

na. Apical nectophore.
nb. Basal nectophore.
ni. Hydrœcial groove enclosed between two wings (*nl*, left wing; *nx*, right wing).
np. Pedicle of the nectophore.
cp. Pedicular canal.
cs. Ascending pallial canal.
cs'. Descending pallial canal.
cv. Ventral canal.
cd. Dorsal canal.
cx. Right canal.
cl. Left canal.
cc. Ring-canal.
a. Trunk.
w. Subumbrella.
v. Velum.

Praya galea, n. sp. (p. 146).

Diam.

Fig. 1. A complete living corm. The nectosome is composed of two large opposite nectophores. The siphosome, in the perfectly expanded state about two feet long, bears a series of forty to fifty cormidia, separated by regular, equal, free internodes, . . . nat. size.

Fig. 2. The two nectophores, seen in their natural junction, from the dorsal side of the first (smaller) bell.

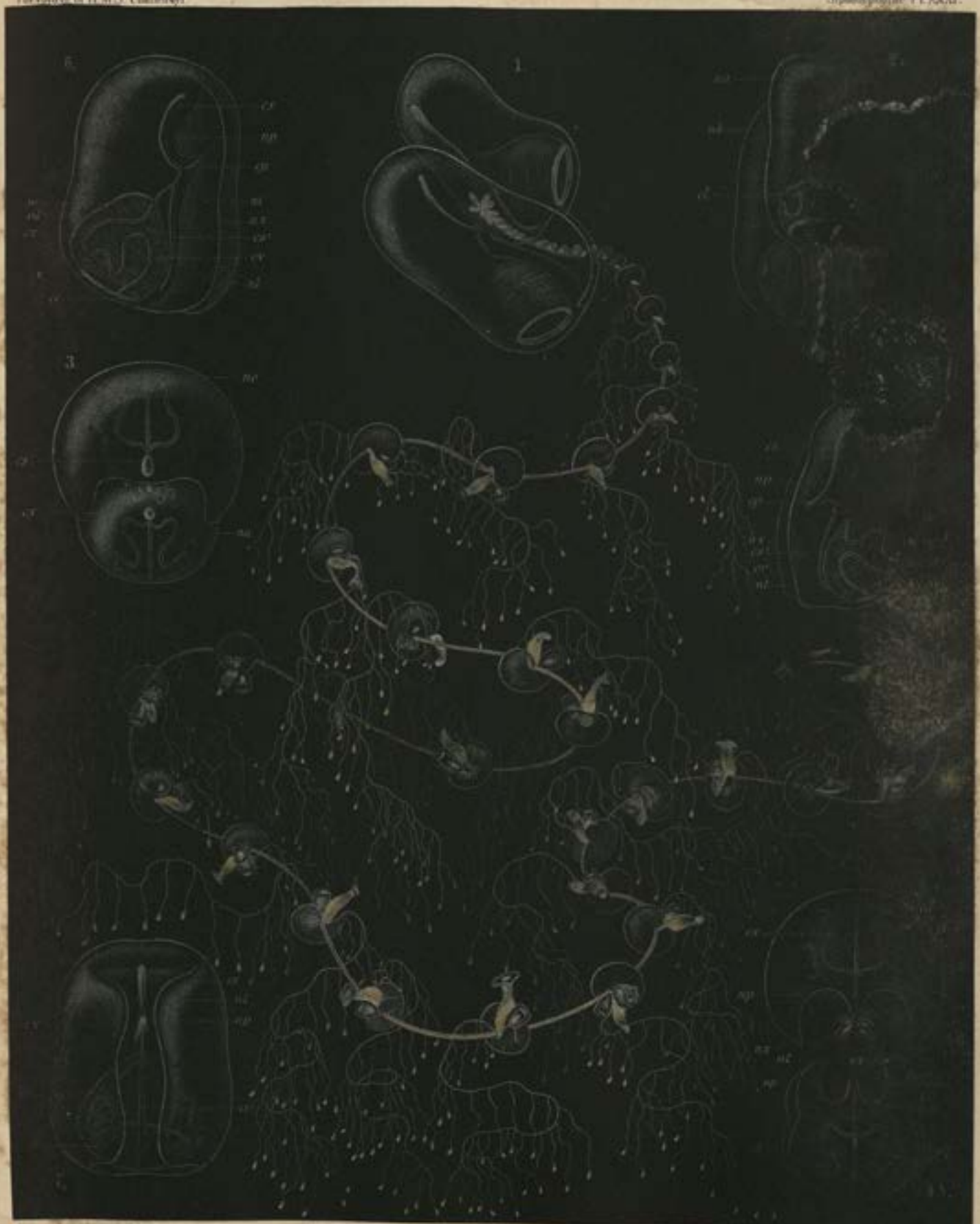
Fig. 3. The two nectophores, seen in their natural junction, from above (from the apex). For "*no*" read "*nb.*"

Figs. 4A, 4B. The two nectophores, in the same view as in fig. 3, but separated one from the other. The two lateral wings (*nx* right, *nl* left), which arise from the ventral side of each bell, include an open hydrœcial groove (*ni*), and in the median ventral line of this latter arises the pedicle of the nectophore (*np*).

Fig. 5. The first or apical nectophore, in lateral view (from the left side).

Fig. 6. The second or basal nectophore, in lateral view (from the right side).

Fig. 7. The second or basal nectophore, in ventral view (from the axial side). The open hydrœcial groove is visible between the two ventral wings of the bell (*nx* right, *nl* left wing).



PRAYA GALEA.

PLATE XXXII.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Eudoxella galea.
(Monogastric generation of *Praya galea.*)

PLATE XXXII.

The figures of this Plate were drawn by me from living specimens, in the Canary Island Lanzerote, February 17–20, 1867, except the bract, fig. 9, and the tentillum, fig. 14, which were found in a bottle in the Challenger collection from Station 352.

Eudoxella galea, n. sp. (pp. 108, 148).

(Monogastric generation of *Praya galea*, Pl. XXXI.)

Fig. 8. A single cormidium or eudoxome, sessile on the stem (*a*), composed of two medusomes or medusoid persons. The sterile medusome is composed of a helmet-shaped or reniform bract (*b*), a siphon (*s*), and a tentacle (*t*). The fertile medusome is a male gonophore (*h*), attached to the ventral side of the siphon (*s*). The latter exhibits eight yellow hepatic ridges (*sh*) in the wall of its stomach. The mouth (*so*) is closed. The bract (*b*) exhibits the four radial canals of a medusome-umbrella, bilaterally developed, dorsal (*cd*), ventral (*cv*), right (*cx*), and left (*cl*). They are connected by the bracteal canal (*ca*) with the stem (*a*). The long tentacle (*t*) is articulated and beset with numerous tentilla.

Fig. 9. A single bract, with its four radial canals. Characters as in fig. 8; *w*, subumbrella.

Fig. 10. A female gonophore. The ovarium (*f*) is suspended in the apex of the subumbrella (*w*). The bilateral umbrella exhibits a very large dorsal wing (*nd*) and a smaller ventral wing (*nv*); *v*, velum.

Fig. 11. A siphon, doubly invaginated. The basigaster (*sb*) is strongly expanded and has taken into it the retracted stomach (*sh*); the cavity of the latter again contains the basal part of the invaginated proboscis (*sr*). The mouth (*so*) is closed.

Fig. 12. A tentillum, seen from the convex dorsal side. *km*, Small median cnidocysts; *kl*, large lateral cnidocysts; *kp'*, *kp''*, pyriform distal cnidocysts; *ts*, pedicle; *tf*, terminal filament.

Fig. 13. A tentillum seen from the left side. Characters as in fig. 12.

Fig. 14. A tentillum, strongly contracted, from the right side. Characters as in fig. 12.

Fig. 15. The first or apical nectophore of a young corm, with a bunch of numerous buds (*i*).

PRAYA GALEA.

PLATE XXXIII.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Diphyopsis compressa.

PLATE XXXIII.

The figures of this Plate were drawn by me from living specimens in the Canary Island Lanzerote, December 28–30, 1866.

Diphyopsis compressa, n. sp. (p. 153).

Diam.

Fig. 1. A complete living corm, with expanded siphosome. The first (apical) nectophore is seen from its left side, the second (basal) from its right side. *cs*, Somatocyst of the superior or proximal nectophore; *cp*, coryphal canal; *w*, subumbrella; *ni*, hydrœcium; *ub*, ventral face of the umbrella; *np*, pedicle of the inferior or distal nectophore; *nl*, its overlapping left wing; *nd*, dorsal edge, . × 3

Fig. 2. The two nectophores, united, seen from the ventral side of the first. *cs*, Somatocyst; *cp*, coryphal canal; *w*, subumbrella; *nf*, hydrœcial canal (infundibular furrow); nf^1, its superior fissure; nf^3, its inferior fissure; *ni*, hydrœcium of the first nectophore; *a*, the included stem, × 3

Fig. 3. The two nectophores, united, seen from the dorsal side of the first. Characters as in fig. 2. The second nectophore exhibits distinctly the left mantle-lobe of its umbrella (*nl*) overlapping the inferior part of the hydrœcial canal, . . × 3

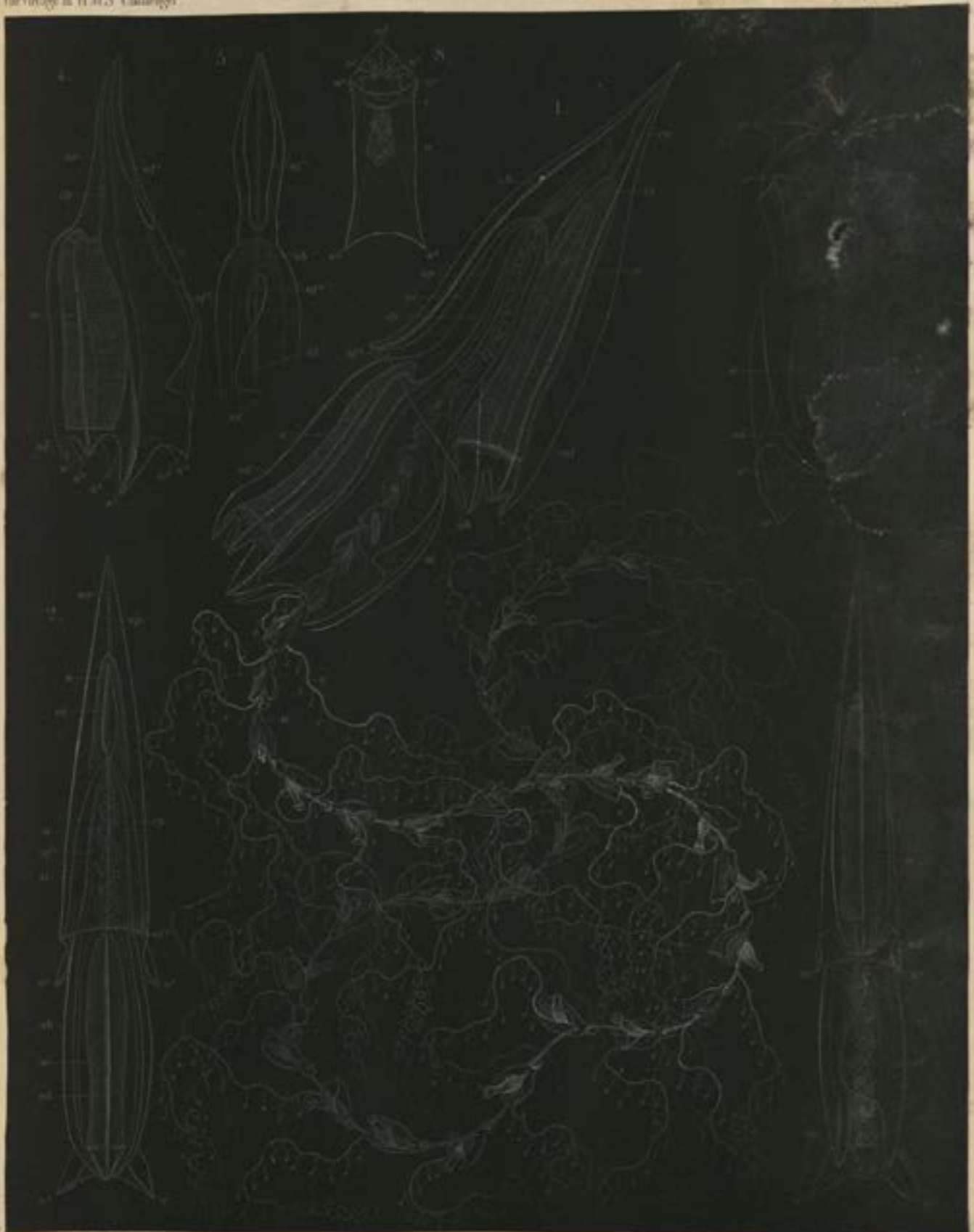
Fig. 4. The basal (distal or second) nectophore, seen from its right side. *np*, Pedicle, with the apical canal (*cp*); nf^1, superior, and nf^2, inferior fissure of the hydrœcial canal; *w*, subumbrella; *nd*, odd dorsal tooth; n^1–n^6, three pairs of basal teeth, two of which (n^1–n^4) surround the ostium of the umbrella, ... × 3

Fig. 5. Apical part of the same nectophore, seen from its ventral side, exhibiting the bridge (*ub*) between the two fissures of the hydrœcial canal (nf^1, nf^2), and the overlapping left mantle-lobe (*nl*), ... × 3

Fig. 6. Basal ostium of the apical (proximal or first) nectophore, seen from below; *v*, velum; *nd*, odd dorsal tooth; n^1, left, n^2, right, lateral teeth; n^3, left, n^4, right, ventral teeth; *cr*, ring-canal, . . × 6

Fig. 7. Basal part of the same nectophore, seen from its dorsal side. Characters as in fig. 6, ... × 6

Fig. 8. Basal view of the same nectophore, exhibiting the rectangular mouth of the hydrœcium or the infundibular cavity, in which is hidden the contracted siphosome (*a*). Characters as in fig. 6.



DIPHYOPSIS COMPRESSA.

PLATE XXXIV.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Eudoxa compressa.
(Monogastric generation of *Diphyopsis compressa.*)

PLATE XXXIV.

Ersæa compressa, n. sp. (p. 123).

(Monogastric generation or free Eudoxia of *Diphyopsis compressa*, Pl. XXXIII.)

Fig. 9. A sessile young cormidium (or an immature *Ersæa*) attached to the stem (*a*) of *Diphyopsis compressa*. The cormidium is composed of two sterile medusomes, the first consisting of the bract (*b*), the siphon (*s*), and the tentacle (*t*); the second representing a "special nectophore" (*nn*); *cr*, radial canals of the latter; *so*, mouth of the siphon; *sb*, basigaster; *cs*, phyllocyst; *co*, oleocyst.

Fig. 10. A somewhat older cormidium than that shown in fig. 9, with larger nectophore (*nn*) and smaller bract (*b*) detached from the stem. Characters as in fig. 9; *w*, subumbrella of the nectophore; *v*, its velum; *uo*, ostium of the umbrella (*u*). The bract (*b*) of this specimen is rudimentary, and its apical cucullate part (with the phyllocyst) is cut off; *tk*, cnidosacs of the tentacle.

Fig. 11. A mature and fully developed male *Ersæa*, detached from the stem of *Diphyopsis compressa*, and swimming freely. The cormidium is composed of four persons, two sterile medusomes and two male gonophores (*h*). The first sterile medusome consists of a bract (*b*), a siphon (*s*), and a tentacle (*t*). The second sterile medusome is represented by a large "special nectophore" (*nn*). *bs*, Superior, cucullate part of the bract, with the phyllocyst (*cs*) and the oleocyst (*co*); *bz*, inferior, mantle-shaped or funnel-shaped, part of the bract, with four basal lobes; *so*, mouth of the siphon; *sb*, basigaster; *tk*, cnidosacs of the tentacle (*t*); *hx*, cavity of the spadix; *hm*, spermarium.

Fig. 12. An isolated ripe androphore. *hm*, Spermarium; *hx*, cavity of the spadix; *u*, umbrella; *uo*, its ostium.

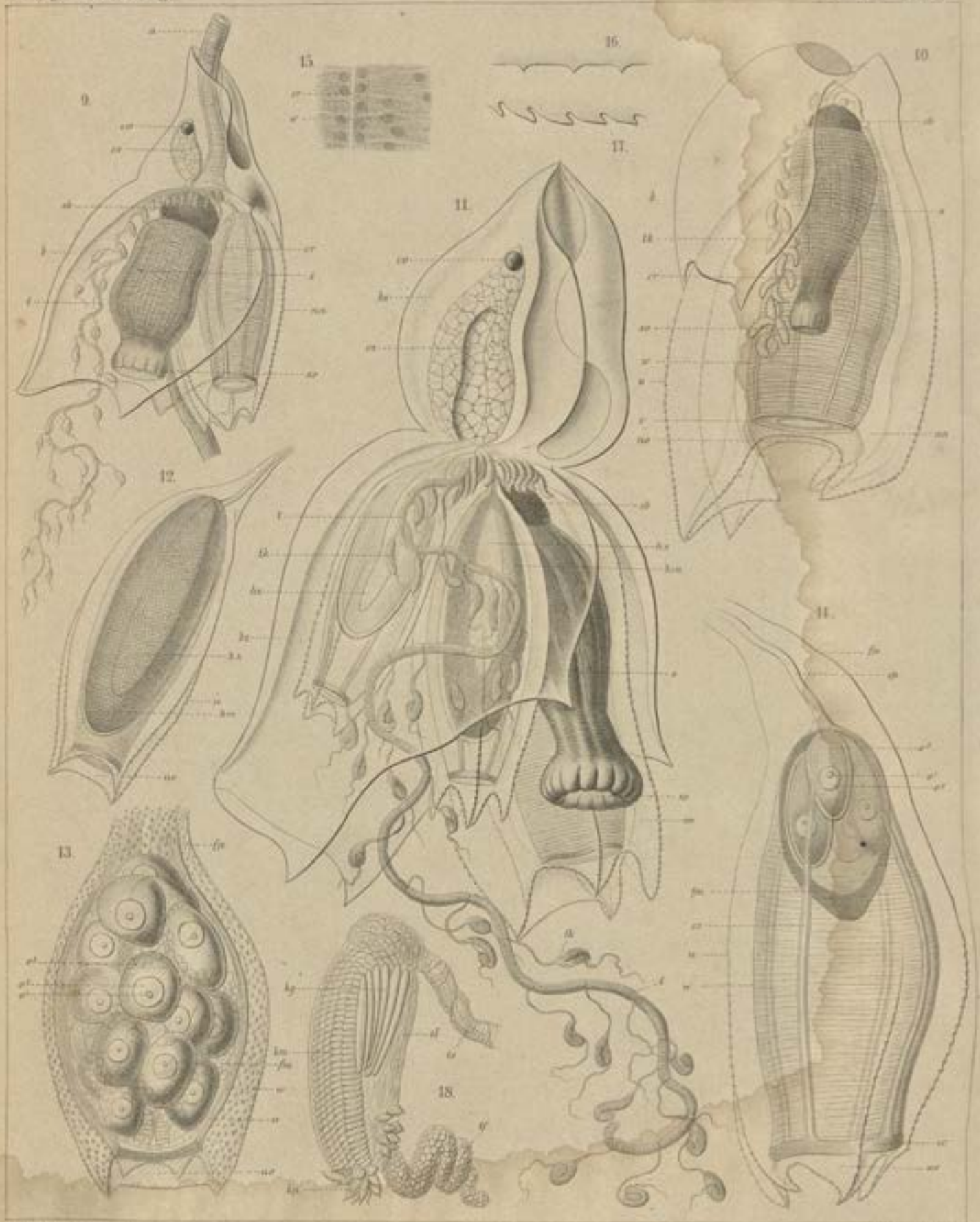
Fig. 13. An isolated ripe gynophore. The manubrium (*fm*) is filled with large ovules. o^1, Nucleolus; o^2, nucleus; o^3, protoplasm of the ovule; *fp*, pedicle; *w*, subumbrella; *u*, umbrella; *uo*, its ostium.

Fig. 14. An older gynophore, the manubrium (*fm*) of which contains only four large ovules. *cc*, Circular canal which connects the four radial canals (*cr*); *fp*, pedicle of the gonophore; *cp*, peduncular canal. The other characters as in fig. 13.

Fig. 15. A portion of a radial canal (*cr*) and of the ring-muscles of the subumbrella (*w*) of a gonophore.

Figs. 16, 17. Denticulate edges of the umbrella of a gonophore.

Fig. 18. A single tentillum, highly magnified. *ts*, Pedicle; *tl*, elastic ligament of the cnidosac; *kg*, large lateral cnidocysts; *km*, small median cnidocysts; *kp*, distal pyriform cnidocysts; *tf*, terminal filament.



DIPHYOPSIS COMPRESSA.

PLATE XXXV.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Abyla carina.

PLATE XXXV.

Drawn from life by me in the Canary Island Lanzerote, February 11, 1867.
The signification of the characters is the same in all the figures :—

nd. Dorsal edge of the nectophore.
nx. Right wing.
nl. Left wing.
ud. Dorsal face.
uv. Ventral face.
ut. Transverse frontal crest.
uo. Ostium of the umbrella.
ui. Hydrœcium.
w. Subumbrella (Nectosac).

cs. Somatocyst (Acrocyst).
cd. Dorsal canal.
cv. Ventral canal.
cx. Right canal.
cl. Left canal.
nq. Articular condyle of the second nectophore.
as. Trunk of the siphosome.
v. Velum.

Abyla carina, n. sp. (p. 156).

Diam.

Fig. 1. The complete living corm, in its natural position, floating with subhorizontal main axis on the level of the sea. A bunch of tentacles issues by the basal opening of the hydrœcial canal. The first and smaller (apical) nectophore is seen from the right side, the second and larger (basal) nectophore from the left side, . . . × 3

Fig. 2. The same corm, in the same natural position, seen from the apical face, × 3

Figs. 3–7. Different views of the first (proximal or apical) nectophore, . . × 6

Fig. 3. Apical view of the first nectophore; the nectosac (w^1) appears through its dorsal apical facette. (For "*cb*" read "*cl.*")

Fig. 4. Basal view of the first nectophore; in the ventral half of the base is visible the opening of the hydrœcium (*ui*), including the siphosome (*as*); in the dorsal half the ostium of the nectosac (w^1).

Fig. 5. Lateral view of the first nectophore, from the right side. w^1, Nectosac; *ui*, hydrœcium; *cs*, somatocyst.

Fig. 6. Ventral view of the first nectophore, with the somatocyst (*cs*).

Fig. 7. Dorsal view of the first nectophore, with the nectosac (w^1).

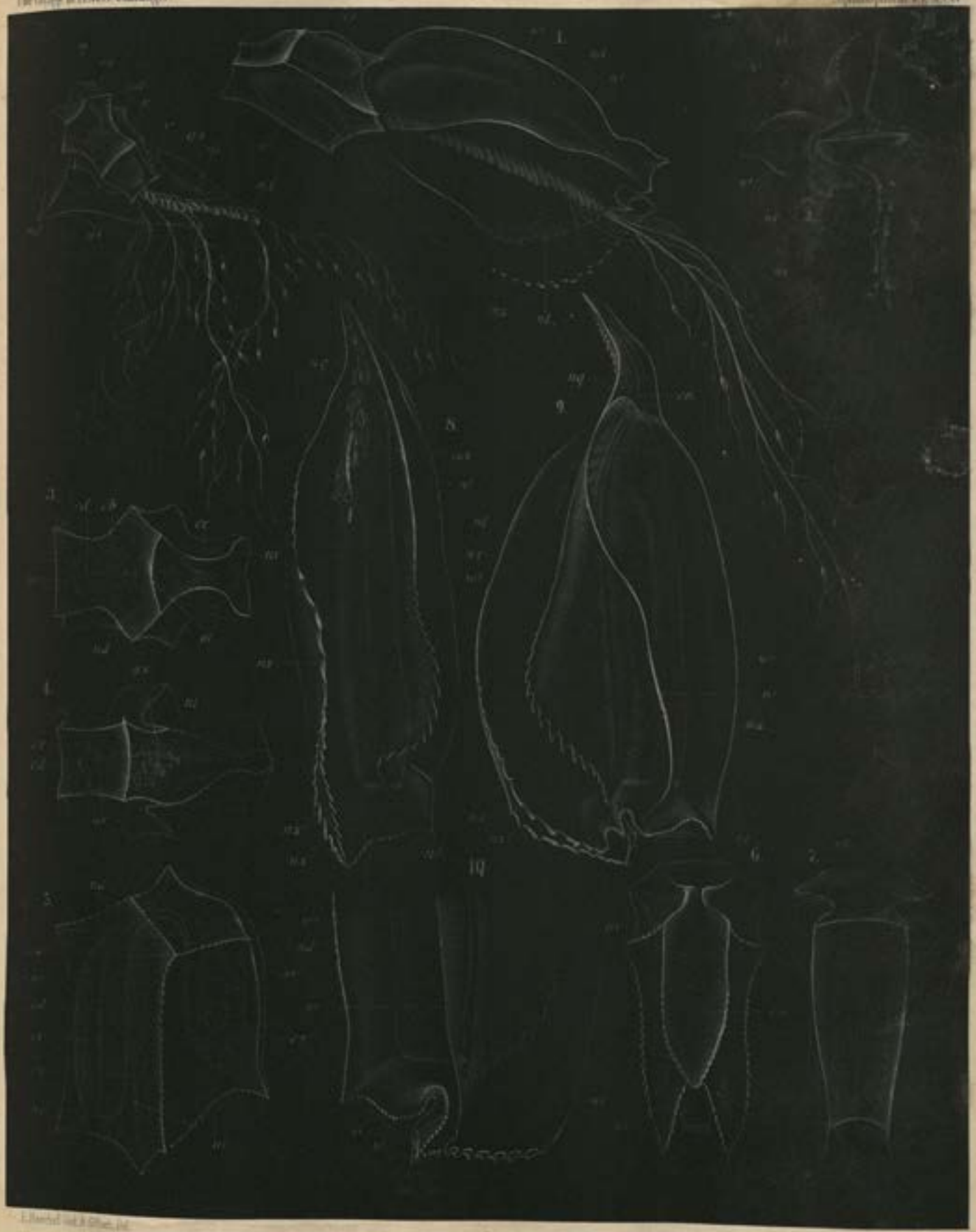
Figs. 8–11. Different views of the second (distal or basal) nectophore, . . × 4

Fig. 8. Ventral view of the second nectophore, with the siphosome (*as*) enclosed in the hydrœcial canal.

Fig. 9. Lateral view of the second nectophore, from the left side. w^2, Nectosac.

Fig. 10. Lateral view of the basal part of the second nectophore, from the right side.

Fig. 11. Basal view of the second nectophore, from below, with the five teeth surrounding the basal ostium.



ABYLA CARINA.

PLATE XXXVI.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Amphiroa carina.
(Monogastric generation of *Abyla carina.*)

PLATE XXXVI.

The signification of the characters is the same in all the figures :—

b. Bract.
bc. Phyllocyst.
ca. Right canal of the phyllocyst.
cl. Left canal of the phyllocyst.
cp. Coryphal canal.
va. Apical face of the bract.
vd. Dorsal face of the bract.
s. Siphon.
so. Its mouth.

t. Tentacle.
h. Androphore.
hs. Spermarium.
f. Gynophore.
fo. Ovarium.
w. Subumbrella.
ny. Asymmetrical ventral wing of the gonophore.
nz. Dentate asymmetrical (external) dorsal wing of the gonophore.

Amphiroa carina, n. sp. (p. 114).

(Monogastric generation or free Eudoxia of *Abyla carina*, Pl. XXXV.)

Diam.

Fig. 12. Lateral view of a complete immature Eudoxia, attached to the stem of *Abyla*, from the right side. The monogastric corm is composed of two medusomes, a male gonophore (*w*) and a sterile person (with a bract, a siphon, and a tentacle), ... × 10

Fig. 13. Lateral view of a similar immature Eudoxia, attached to the stem, from the left side, ... × 8

Fig. 14. Ventral view of a mature Eudoxia, with a single female gonophore, . × 6

Fig. 15. Dorsal view of the same Eudoxia, ... × 6

Fig. 16. Apical view of the same Eudoxia (from above), . . . × 6

Fig. 17. Basal view of the same Eudoxia (from below), . . . × 6

Fig. 18. Lateral view of a monoclinic Eudoxia, from the left side, with a larger androphore and a smaller gynophore, ... × 6

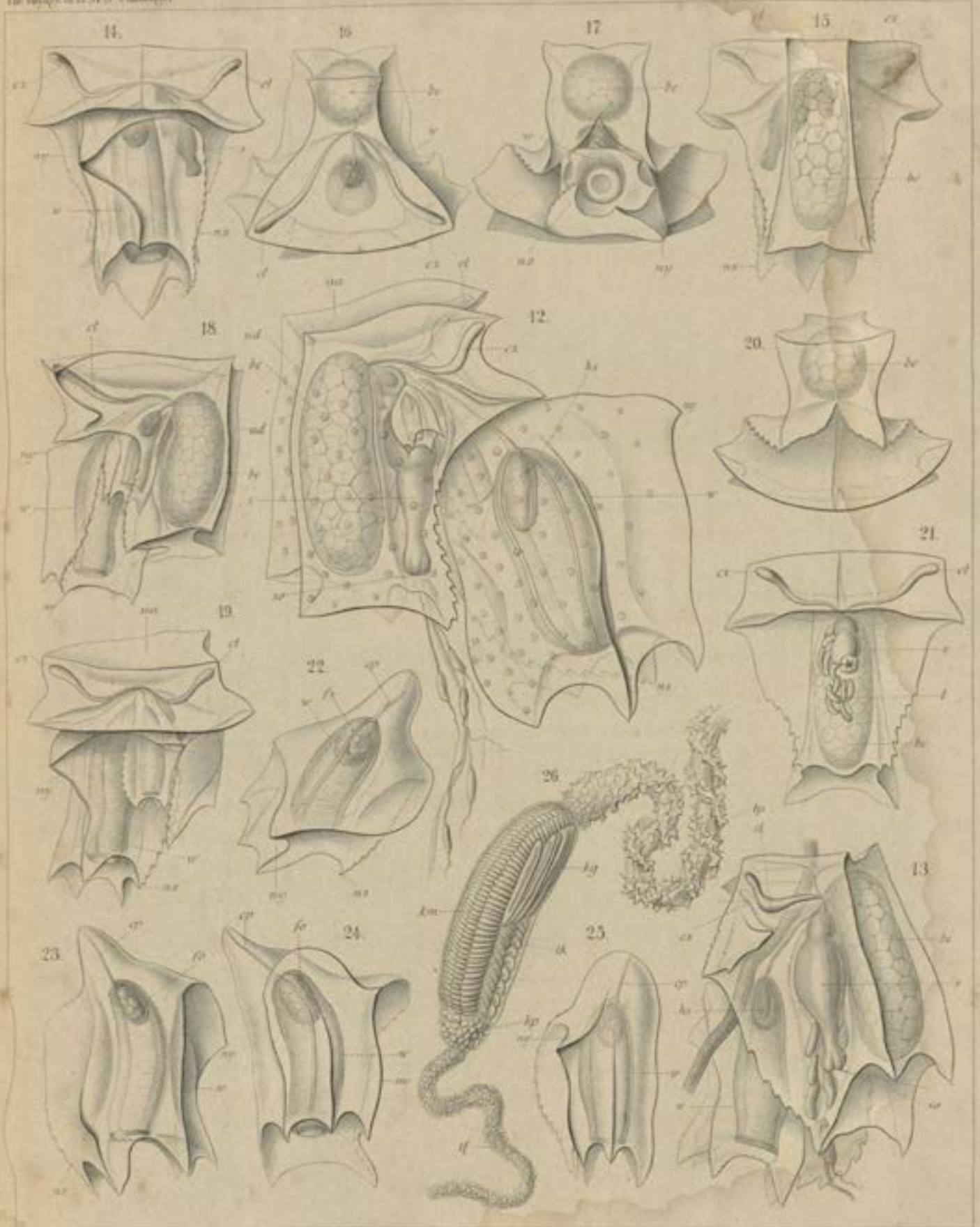
Fig. 19. Ventral view of a monoclinic Eudoxia, ... × 6

Fig. 20. Apical view of an isolated bract (from above), . . . × 6

Fig. 21. Ventral view of a sterile medusome (with bract, siphon, and tentacle), × 6

Figs. 22–25. Different views of gynophores, exhibiting the peculiar asymmetrical development of the pentagonal umbrella (compare p. 115). In fig. 22, for "*fs*" read "*fo*," . . . . . × 6

Fig. 26. A single tentillum, much enlarged. *tp*, Pedicle ; *tk*, cnidosac ; *kg*, large, lateral, ensiform cnidocysts; *km*, small, median, paliform cnidocysts ; *kp*, small, distal, pyriform cnidocysts ; *tf*, terminal filament.



ABYLA CARINA (AMPHIROA).

PLATE XXXVII.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Bassia obeliscus.

PLATE XXXVII.

Drawn by me from living specimens in the Canary Island Lanzerote, in February 1867.
The signification of the characters is the same in all the figures :—

a. Angles of the nectophores.
uo. Ostium of the nectosac.
ud. Dorsal face of the nectophore.
uv. Ventral face of the nectophore.
ui. Hydrœcium.
v. Velum.
vk. Overlapping wing (Valvula hydrœcii).
va. Left face of the apical nectophore.
vb. Subumbrella.
ak. Coryphal edge of the umbrella.
cs. Somatocyst.
cd. Dorsal canal.
cv. Ventral canal.
cr. Right canal.
cl. Left canal.
cc. Ring-canal.
st. Trunk of the siphosome.
i. Buds of cormidia.

Bassia obeliscus, n. sp. (p. 160).

Diam.

Fig. 1. Lateral view of the complete corm. The main axis of the smaller (apical) nectophore is nearly horizontal, and perpendicular to the vertical main axis of the larger (distal) nectophore; the former is seen from the left side, the latter from the right side. The siphosome, arising from the apex of the hydrœcium in the apical nectophore, passes through the funnel-canal of the distal nectophore and projects freely through its basal aperture, ... × 8

Fig. 2. Lateral view of the complete corm, from the opposite side. The first nectophore is seen from the right side, the second from the left side, × 6

Fig. 3. Ventral view of the complete corm. The smaller (proximal) nectophore is seen from its basal side, the larger (distal) nectophore from its ventral side, ... × 6

Fig. 4. Oblique view of the complete corm. The smaller (proximal) nectophore is seen from the apical edge (*nk*), the larger (distal) nectophore half from the left, half from the dorsal side, ... × 6

Figs. 5–8. Different views of the first (proximal or apical) nectophore, . . × 8

Fig. 5. Ventral view of the first nectophore. The somatocyst (*cs*) is visible in the upper half, the hydrœcium (*ui*) with the siphosome (*i*) in the lower half.

Fig. 6. Dorsal view of the first nectophore. The somatocyst (*cs*) is visible in the upper half, the nectosac (*uo*) in the lower half.

Fig. 7. Apical view of the first nectophore. *cs*, Somatocyst.

Fig. 8. Basal view of the first nectophore. *uo*, Aperture of the nectosac; *v*, velum.

Fig. 9. Basal view of the second (distal or basal) nectophore. The nectosac with its small circular aperture, the velum (*v*), and the four radial canals are visible in the left-hand (dorsal) half of the figure; the opening of the funnel-canal (*ui*) and the included siphosome (*a*) in the right-hand (ventral) half. (For "*n*" read "*cc*"), . . . × 8

Fig. 10. Apical portion of the second nectophore, exhibiting the coryphal apophysis or the articular condyle, through the opening of which the siphosome (*a*) enters into the hydrœcial canal (*ui*), . . × 8

Fig. 11. Apical nectophore of a variety (?), or another species (?), . . × 8

BASSIA OBELISCUS

PLATE XXXVIII.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Sphenoides obeliscus.
(Monogastric generation of *Bassia obeliscus.*)

PLATE XXXVIII.

Sphenoides obeliscus, n. sp. (p. 116).

(Monogastric generation or free Eudoxia of *Bassia obeliscus*, Pl. XXXVII.)

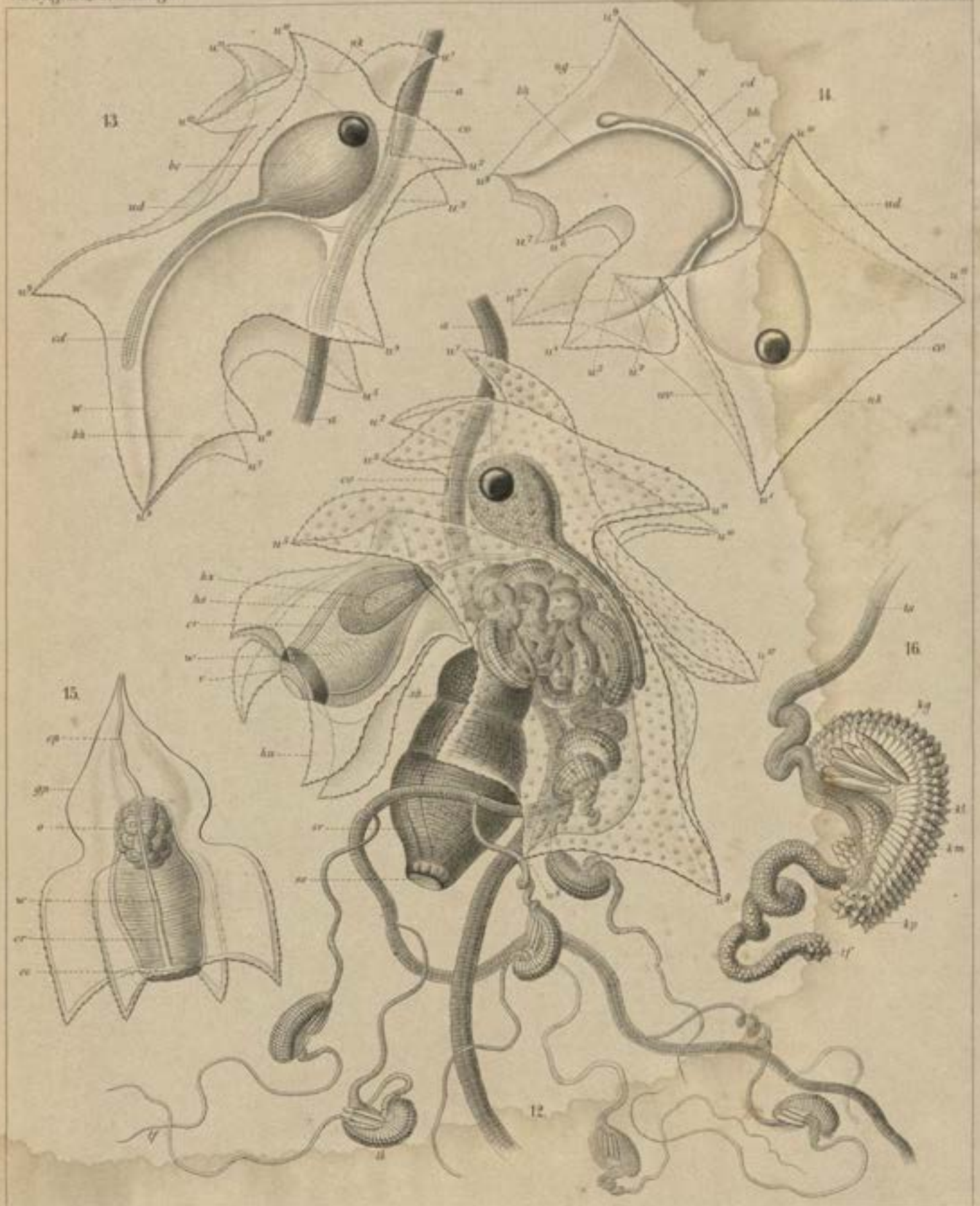
Fig. 12. A complete Eudoxia, attached to the stem (*a*) of the polygastric generation, *Bassia obeliscus*, seen from the left side. The bilateral bract (*u*) is beset with scattered groups of cnidocysts, and exhibits twelve prominent pyramidal teeth (characters u^1–u^{12} as in fig. 13). Its large phyllocyst contains an apical oleocyst (*co*). The siphon (*s*) is placed between the dorsal tentacle (*t*) and the ventral male gonophore (*h*). The numerous tentilla (*tk*) are partly expanded (below), partly coiled up (above).

Fig. 13. Bract of a young sessile Eudoxia, attached to the stem (*a*), seen from the right side. The twelve prominent three-sided pyramidal teeth have denticulate edges and the following names:—u^1, odd ventral apical tooth; u^2, u^3, ventro-lateral apical teeth; u^4, u^5, ventro-lateral basal teeth; u^6, u^7, dorso-lateral basal teeth; u^8, odd dorsal basal tooth; u^9, odd dorsal cristal tooth; u^{10}, u^{11}, dorso-lateral teeth; u^{12}, odd dorsal apical tooth. *bh*, Cavity of the bract; *w*, its subumbrellar wall; *bc*, phyllocyst; *cd*, its basal cæcum (dorsal canal); *co*, oleocyst.

Fig. 14. Bract of an adult free Eudoxia, seen from the right side. Characters as in figs. 12 and 13.

Fig. 15. An isolated female gonophore. *cp*, Peduncular canal; *gp*, pedicle of the umbrella; *o*, ovarium; *w*, subumbrella; *cr*, radial canals; *cc*, circular canal.

Fig. 16. A single tentillum. *ts*, Pedicle; *kg*, large basal cnidocysts; *km*, small median cnidocysts; *kp*, pyriform distal cnidocysts; *tf*, terminal filament.



BASSIA OBELISCUS (SPHENOIDES).

PLATE XXXIX.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Calpe gegenbauri.

PLATE XXXIX.

Drawn from life by me in the Canary Island Lanzerote, February 1867.
The signification of the characters is the same in all the figures :—

ud. Dorsal face of the nectophore.
uv. Its ventral face.
uo. Its ostium.
ui. Infundibulum.
w. Subumbrella.
v. Velum.
es. Somatocyst.
en. Oleocyst.
ed. Dorsal canal.
ev. Ventral canal.
ec. Right canal.
el. Left canal.
er. Circular ring-canal.
ul. Coryphal edge of the umbrella.
ud. Dorsal edge of the umbrella.
u^1, u^3. Left edges.
u^2, u^4. Right edges.
uc. Right wing of the hydrœcial canal.
ul. Left wing of the hydrœcial canal.
as. Trunk of the siphosome.

Calpe gegenbauri, n. sp. (p. 164).

Diam.

Figs. 1–4. The entire corm, with the two nectophores in their natural junction, and the enclosed siphosome, seen from four different sides, . × 6

Fig. 1. Ventral view of the second, right lateral view of the first nectophore.

Fig. 2. Dorsal view of the second, left lateral view of the first nectophore.

Fig. 3. Right lateral view of the second, oblique basal view of the first nectophore.

Fig. 4. Left lateral view of the second, oblique apical view of the first nectophore.

Figs. 5–8. The first (proximal or apical) nectophore alone, seen from four different sides, ... × 12

Fig. 5. Apical view of the first nectophore. The nectosac (*w*) shines through the dorsal, the somatocyst (*es*) through the ventral half.

Fig. 6. Dorsal view of the first nectophore, with the nectosac (*w*) shining through.

Fig. 7. Ventral view of the first nectophore; the somatocyst (*es*) is visible in the upper half; the hydrœcium and the included siphosome (*as*) in the lower half.

Fig. 8. Lateral view of the first nectophore, from the left side. *w*, Nectosac; *es*, somatocyst; *as*, siphosome.

Fig. 9. The uppermost part of the second (distal or basal) nectophore, with the upper opening of the hydrœcial canal (*ui*), seen from the ventral side, ... × 12

Fig. 10. The same, seen from above, from the apical side, . . . × 12

Fig. 11. Horizontal transverse section of the second nectophore. *nh*, Its swimming cavity; *as*, siphosome, ... × 6

Fig. 12. Basal view of the second nectophore, from below. *uo*, Ostium of the nectosac; *v*, velum; *ui*, basal opening of the hydrœcial canal, . × 6

CALPE GEGENBAURI.

PLATE XL.

Order CALYCONECTÆ.

Family DIPHYIDÆ.

Aglaisma gegenbauri.
(Monogastric generation of *Calpe gegenbauri.*)

PLATE XL.

Aglaisma gegenbauri, n. sp. (p. 119).

(Monogastric generation or free Eudoxia of *Calpe gegenbauri*, Pl. XXXIX.)

Diam.

Fig. 13. Lateral view of a diclinic (female) cormidium, from the right side (and somewhat from behind). *ua*, Apical face of the umbrella; *ud*, dorsal face; *ux*, right face; *ui*, subumbrella (funnel or bracteal cavity); *bc*, phyllocyst; *co*, oleocyst; *cv*, ventral canal; *cd*, dorsal canal; *cx*, right canal; *cl*, left canal; *s*, siphon; *ss*, suctorial disc of the mouth; *t*, tentacle; *f*, gynophore; *fm*, ovarium, ... × 100

Fig. 14. Lateral view of a hermaphrodite (monoclinic) cormidium, from the left side, and somewhat from before. Characters as in fig. 13; *uv*, ventral face; *ul*, left face. At the right hand of the siphon (*s*) is placed the larger androphore (*h*), at the left hand the smaller gynophore (*f*), ... × 100

Fig. 15. Basal view of the bract (from below). *cd*, Dorsal canal; *cx*, right canal; *cl*, left canal, ... × 50

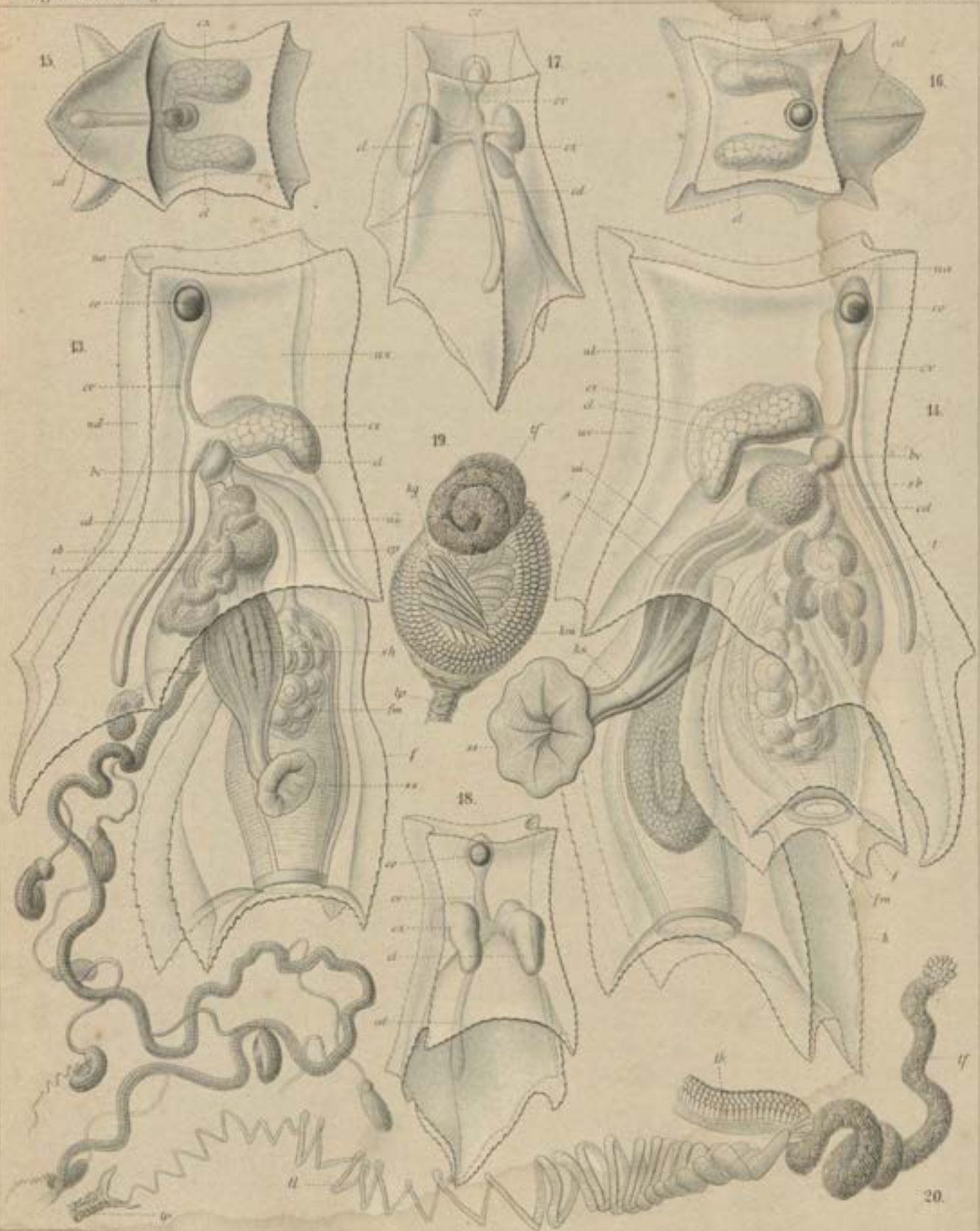
Fig. 16. Apical view of the bract (from above). Characters as in fig. 15; *co*, oleocyst, ... × 50

Fig. 17. Oblique dorsal view of the bract (somewhat from above and left hand). Characters as in figs. 15, 16; *cv*, ventral canal, . . × 50

Fig. 18. Oblique ventral view of the bract (somewhat from above and right hand). Characters as in figs. 15–17, ... × 50

Fig. 19. A single tentillum, in a highly contracted state, much enlarged. *tp*, Pedicle; *kg*, large lateral cnidocysts; *km*, small median cnidocysts; *tf*, terminal filament, spirally coiled up, . . . × 300

Fig. 20. A single tentillum, in a highly expanded state, much enlarged. *tp*, Pedicle; *tl*, elastic ligament (angle-band); *tk*, cnidobattery; *tf*, terminal filament, ... × 300



CALPE GEGENBAURI (AGLAISMA).

PLATE XLI.

Order CALYCONECTÆ.

Family MONOPHYIDÆ.

Cymba crystallus.

PLATE XLI.

Drawn by me from living specimens in the Canary Island Lanzerote, February 1867.
The signification of the characters is the same in all the figures :—

cs. Somatocyst.	*cd.* Dorsal canal.
co. Oleocyst.	*cv.* Ventral canal.
ui. Hydrœcium.	*cr.* Right canal.
a. Trunk of the siphosome.	*cl.* Left canal.
i. Buds.	*cc.* Circular ring-canal.
v. Velum.	For the other characters, compare the special description, pp. 139, 140.
w. Subumbrella.	

Cymba crystallus, n. sp. (p. 138).

Diam.

Fig. 1. Basal view of the complete corm (from below). The quinquedentate mouth of the nectosac (*no*) is visible in the centre of the figure, and beyond it the quadridentate aperture of the hydrœcium (*ui*); in the latter is hidden the retracted siphosome (*a*), ... × 8

Fig. 2. Apical view of the complete corm (from above). The superior or proximal half of the nectophore is visible, divided by four serrate, cruciate, perradial edges into four nearly equal quadrants. In the middle of each quadrant descends an interradial apophysis. The apex of the nectosac (*w*) appears in the centre of the figure through the upper (dorsal) half of the nectophore, the apex of the hydrœcium (*ui*) through its lower (ventral) half, ... × 8

Fig. 3. Dorsal view of the nectophore, with its subumbrellar nectosac (*w*), . × 4

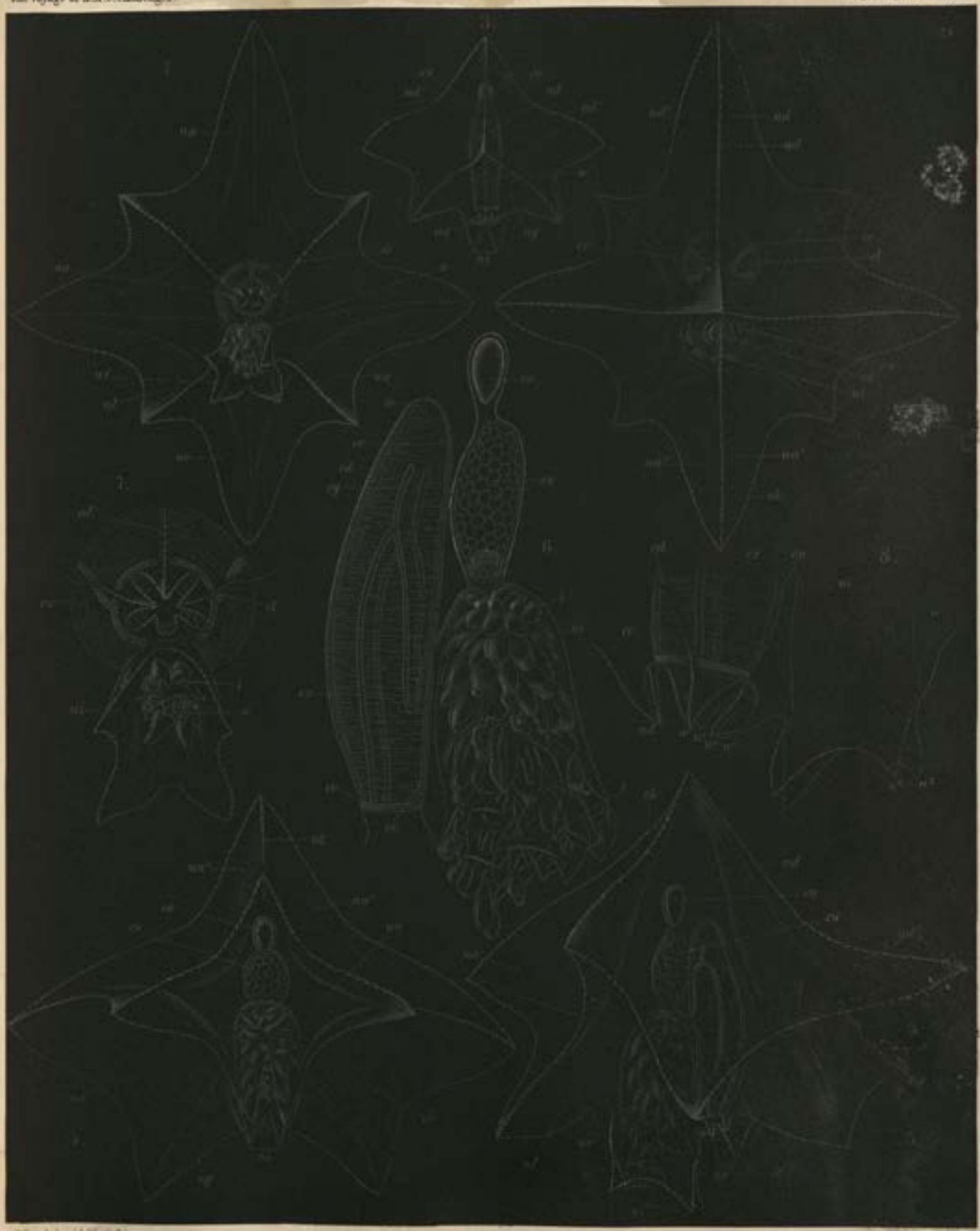
Fig. 4. Ventral view of the complete corm (anterior side). The hydrœcium with its basal mouth (*ui*) and the included siphosome, above it the somatocyst (*cs*), and at its apex the oleocyst (*co*), appear through the pentagonal ventral face of the nectophore. This is surrounded by four interradial faces, two smaller apici-lateral (*ua''* right, *ua'* left) and two larger basi-lateral (*ux* right, *ul* left), . . . × 8

Fig. 5. Lateral view of the complete corm, from the left side. The nectosac with its mouth (*uo*) appears through the dorsal half of the nectophore, the hydrœcium with the included siphosome (*i*) through the ventral half, above it the somatocyst (*cs*) and the oleocyst (*co*), . × 8

Fig. 6. The nectosac (*w*) and the hydrœcium (*ui*) in lateral view, from the right side. The retracted siphosome (*i*) is included in the hydrœcium, above it the somatocyst (*cs*), and at its apex the oleocyst (*co*), × 16

Fig. 7. The mouth of the nectosac (with five teeth), and beyond it the mouth of the hydrœcium (*ui*) with the included siphosome (*a*). Basal view of the central portion of the nectophore, . . . × 16

Fig. 8. Lateral view of the mouth of the nectophore (from the right side), . × 16



E. Ziegler del. et lith.

E. Ziegler, Zool. Lithogr.

CYMBA CRYSTALLUS

PLATE XLII.

Order CALYCONECTÆ.

Family MONOPHYIDÆ.

Cuboides crystallus.
(Monogastric generation of *Cymba crystallus.*)

PLATE XLII.

Drawn by me from living specimens in the Canary Island Lanzerote, in February 1867.
Figs. 9–14 are eight times enlarged, figs. 15–17 more highly magnified.
The signification of the characters is the same in all the figures:—

b. Bract (cuboidal hydrophyllium).
ua. Its apical face.
ud. Dorsal face.
uv. Ventral face.
ux. Right face.
ul. Left face.
ui. Funnel-cavity (subumbrella of the bract).
cs. Phyllocyst.
co. Oleocyst.
s. Siphon.
sb. Basigaster.
so. Its mouth.
t. Tentacle.
k. Cnidosac.
h. Androphore.
hm. Spermarium.
o. Ovary.
v. Velum.
w. Subumbrella.

Cuboides crystallus, n. sp. (p. 112).

(Monogastric generation or free Eudoxia of *Cymba crystallus*, Pl. XLI.)

Fig. 9. Dipersonal corm, in lateral view, from the right side. The infundibulum (*ui*) (or the subumbrellar cavity of the cuboidal bract) includes the siphon (*s*) with its tentacle (*t*), and on its ventral side a male gonophore (*h*).

Fig. 10. Tripersonal corm, in dorsal view. Two male gonophores are placed in the ventral half of the bracteal cavity (*ui*), whilst its dorsal half is occupied by the single siphon and its dorsal tentacle. The phyllocyst exhibits its two pyriform lateral lobes (*cs'* right, *cs''* left), and above them the yellow oleocyst (*co*).

Fig. 11. Dipersonal corm, in oblique lateral view (from the left and somewhat from the dorsal side). A large male gonophore (*h*) occupies the bracteal cavity (*ui*) on the ventral side of the siphon (*s*).

Fig. 12. Dipersonal corm, in dorsal view. The siphon (*s*) occupies the posterior, the gonophore (*h*) the anterior part of the bracteal cavity (*ui*). Above this lies the phyllocyst with its two lateral lobes (*cs''* right, *cs'* left), and above them the oleocyst (*co*).

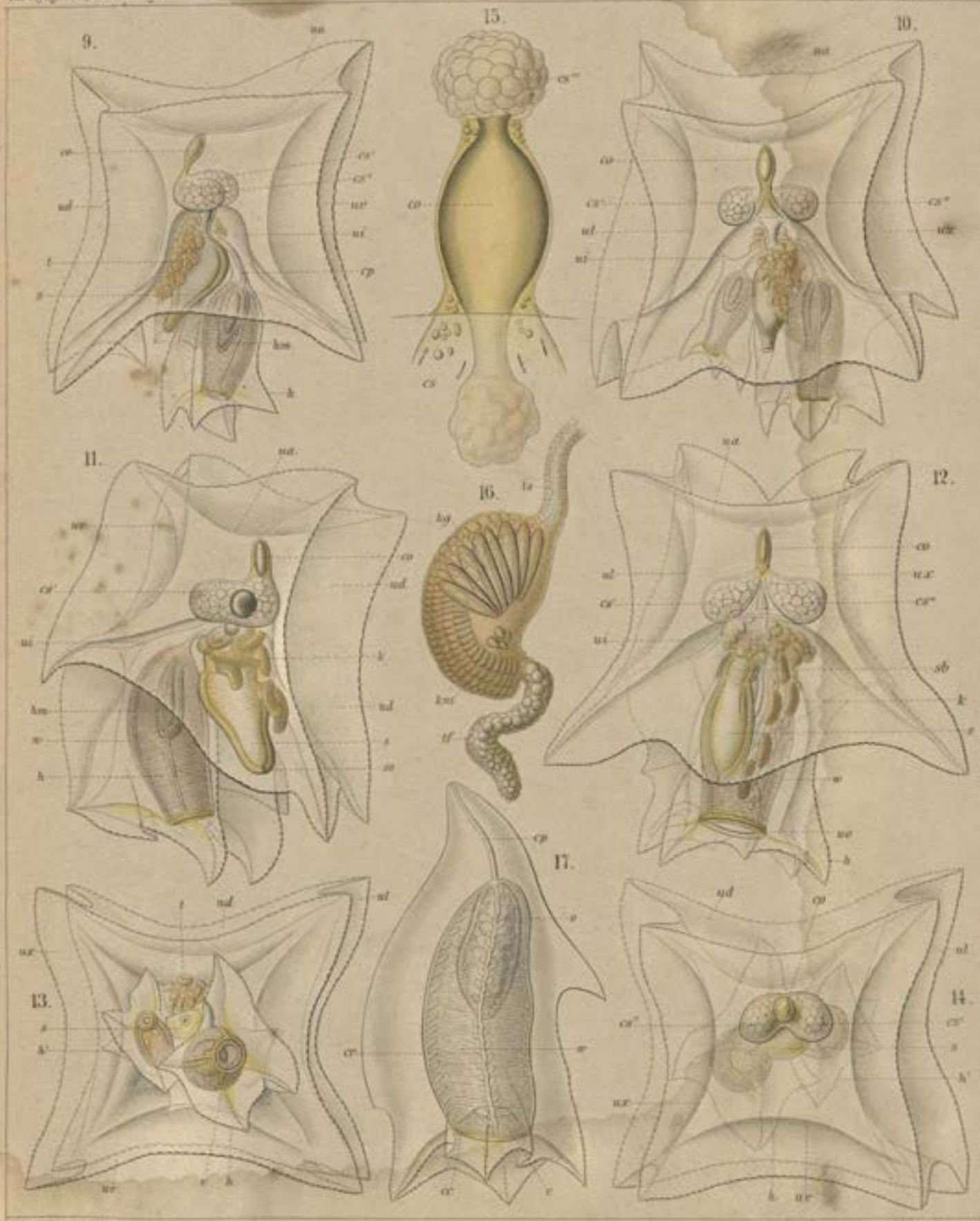
Fig. 13. Tripersonal corm, in basal view. Two male gonophores (*h* and *h'*) are visible beyond the siphon (*s*).

Fig. 14. Tripersonal corm, in apical view. The two lobes of the phyllocyst (*cs''* right, *cs'* left) are visible, and between them the apical oleocyst (*co*).

Fig. 15. The oleocyst (*co*) of an older Eudoxia, with an apical accumulation of entoderm-cells (*cs'''*). The direction of the circulation of the fluid in the median part of the somatocyst is indicated by small arrows.

Fig. 16. A single tentillum. *ts*, Pedicle; *kg*, large lateral cnidocysts; *km*, small median cnidocysts; *tf*, terminal filament.

Fig. 17. A single female gonophore. The radial canals (*cr*) appear elegantly pinnulate. *o*, Ovarium; *v*, velum; *w*, subumbrella; *cp*, peduncular canal; *cc*, ring-canal.



CYMBA CRYSTALLUS (CUBOIDES).

PLATE XLIII.

Order DISCONECTÆ.

Family VELELLIDÆ.

Armenista sigmoides.

PLATE XLIII.

Armenista sigmoides, n. sp. (p. 84).

Diam.

Fig. 1. Apical view of the corm (from above). The diagonal crest of the pneumatophore divides the exumbrella into an antero-dextral and a postero-sinistral half. The limb of the umbrella is octolobate, ... nat. size

Fig. 2. Basal view of the corm (from below). The large sterile central siphon is surrounded by a corona of numerous small sexual siphons, and these by a double corona of filiform tentacles, nat. size

Fig. 3. Half lateral, half superior view of the corm. Numerous filiform tentacles are prominent beyond the limb of the umbrella. The vertical diagonal crest of the pneumatophore exhibits the branched canals of the exumbrella, ... nat. size

Fig. 4. Frontal section through the corm (or vertical transverse section). *ph*, Central chamber of the pneumatocyst (*pf*); *ce*, canals of the umbrella; *um*, limbus umbrellæ; *us*, glands of the umbrella margin; *uc*, centradenia; *uh*, hepatic vessels; *un*, renal vessels; *t*, tentacles; *gs*, gonostyles (sexual siphons); *g*, gonophores; *sa*, sterile central siphon; *sf*, longitudinal folds of its inside; *so*, the octolobate mouth, ... × 4

Fig. 5. Pneumatocyst of a young corm, seen from above. Concentric ring-chambers with their pores of communication (pneumothyræ, *pq*); *pe*, their external openings (stigmata), . . × 2

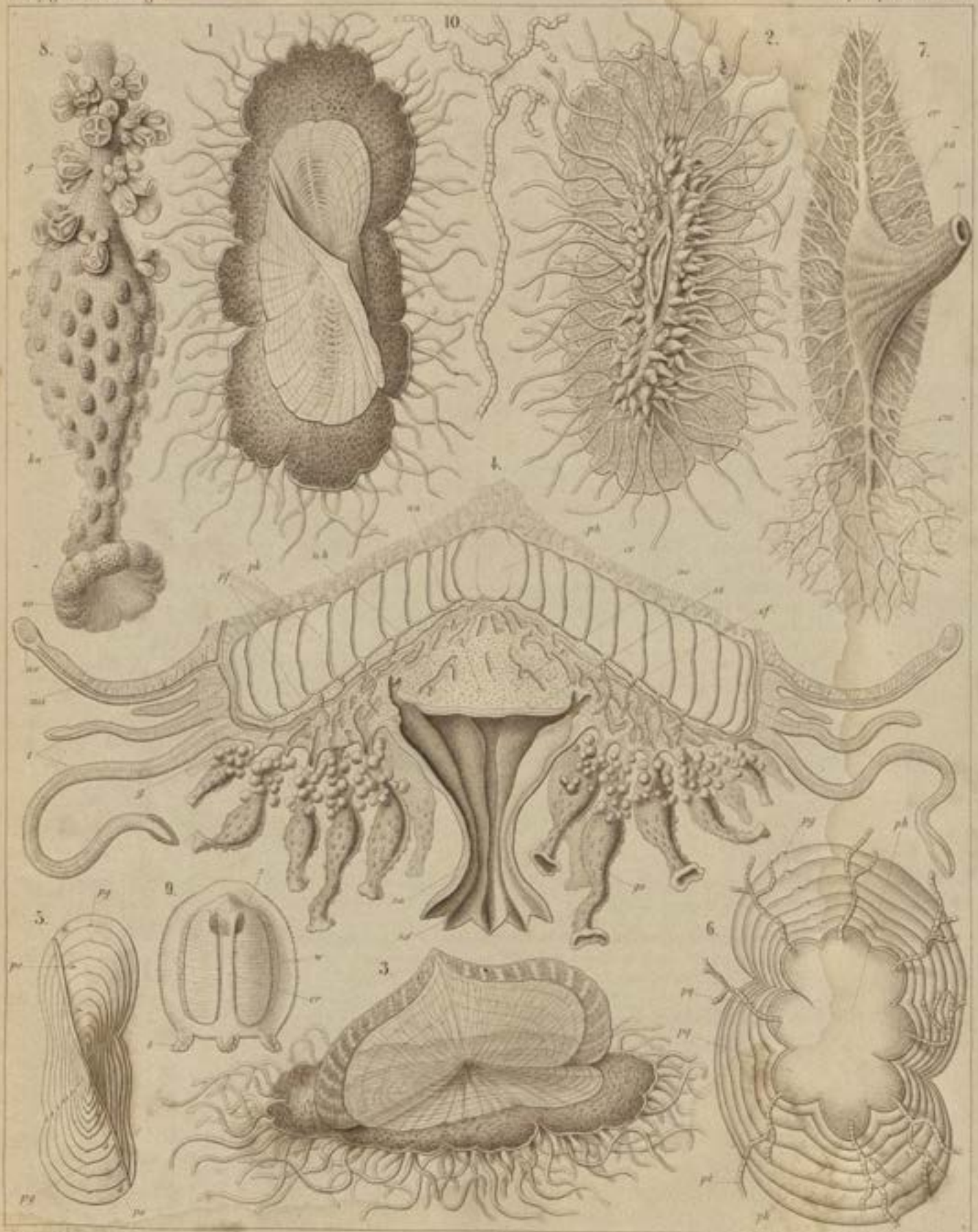
Fig. 6. Central part of the pneumatocyst of a young corm, seen from below, highly magnified. The central chamber (*ph*) is confluent with eight radial chambers (*pq*), each of which bears below a branched trachea. The surrounding concentric ring-chambers (*pk*) are connected by pores of communication (pneumothyræ, *pq*), ... × 20

Fig. 7. Basal view of the isolated centradenia (*uc*) and the central siphon (*sa*), from below. *cm*, Gastro-canal system of the subumbrella; *so*, mouth, ... × 2

Fig. 8. A single gonostyle or sexual siphon. *gs*, Its stomach; *g*, gonophores; *kn*, cnidonodes; *so*, mouth, ... × 20

Fig. 9. A medusiform gonophore, detached from the stem (*Discomitra*), highly magnified. *w*, Subumbrella; *cr*, radial canals accompanied by yellow cells (xanthellæ); *t*, rudimentary tentacles; *s*, the incipient manubrium, ... × 100

Fig. 10. A branched trachea of the pneumatocyst.



ARMENISTA SIGMOIDES.

PLATE XLIV.

Order DISCONECTÆ.

Family VELELLIDÆ.

Rataria cristata.

PLATE XLIV.

Rataria cristata, n. sp. (p. 79).

, Diam.

Fig. 1. Apical view of the corm (from above). *uf*, Vertical sail; *pf*, octolobate central disc of the pneumatocyst; *pk*, its concentric ring-chambers; *um*, margin of the umbrella; *gs*, gonostyles (shining through); *t*, tentacles, ... × 20

Fig. 2. Basal view of the corm (from below). *so*, Mouth-opening of the central sterile siphon; *gs*, sexual siphons (gonostyles); *um*, margin of the umbrella; *t*, tentacles, . . × 20

Fig. 3. Half lateral, half superior view of the corm, swimming in the expanded state. *uf*, Vertical sail; *pf*, pneumatocyst; *ph*, its central chamber; *uc*, centradenia; *um*, margin of the umbrella; *t*, tentacles; *gs*, gonostyles; *sa*, central siphon; *so*, its mouth, . . . × 12

Fig. 4. Lateral view of the corm, in the contracted state. Characters as in fig. 3, . . . × 12

Fig. 5. Frontal section through the corm (or vertical transverse section). Characters as in figs. 1 and 3. *st*, Gastrobasal plate; *cm*, hepatic vessels; *ce*, pallial vessels; *g*, gonophores, . . × 20

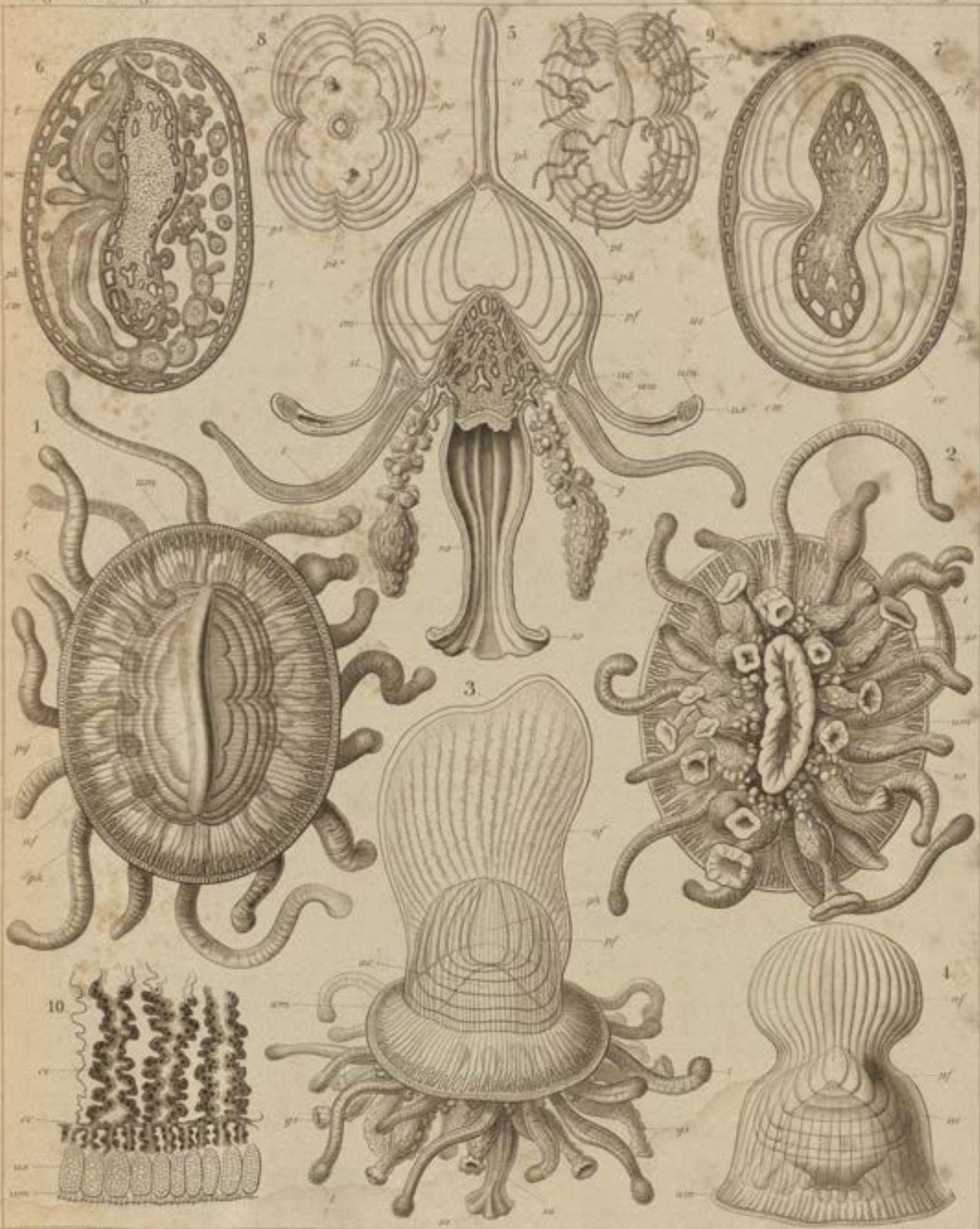
Fig. 6. Horizontal section through the corm, somewhat oblique. The median part of the section exhibits the centradenia (*uc*), with the hepatic vessels (*cm*). The right (inferior) half of the figure shows the transverse sections of the gonostyles (*gs*) and tentacles (*t*); the left (superior) half the peripheral ring-chambers of the pneumatocyst (*pk*), ... × 20

Fig. 7. Horizontal section through the corm, in a transverse plane more highly situated than fig. 6. *pf*, Pneumatocyst; *pk*, its concentric ring-chambers; *uc*, centradenia; *cm*, hepatic vessels; *ce*, pallial vessels of the umbrella margin, ... × 20

Fig. 8. Pneumatocyst of another corm, isolated, seen from above. *po*, Central stigma; *pe*, antero-sinistral stigma; *pe''*, postero-dextral stigma; *pq*, octolobate periphery of the central disc; *pk*, concentric ring-chambers, ... × 20

Fig. 9. The same pneumatocyst, seen from below. *pk*, Concentric ring-chambers; *pt*, trachea, . × 20

Fig. 10. Margin of the umbrella; highly magnified.



RATARIA CRISTATA

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

PLATE XLV.

Order DISCONECTÆ.

Family PORPITIDÆ.

Porpita fungia.

PLATE XLV.

Porpita fungia, n. sp. (p. 67).

Fig. 1. Vertical meridional section through the corm. *p*, Pneumatocyst; *ph*, its central chamber; *pk*, concentric ring-chambers; p^1, tubercles of the upper surface; p^2, thickened chitinous layers of the upper wall; p^3, septa between the ring-chambers; p^4, under surface of a high radial fold; *pe*, stigmata; *uh*, hepatic vessels of the centradenia; *un*, its renal vessels; *uu*, limbus umbrellæ; *t*, tentacles; *gs*, gonostyles; *so*, their mouth; *g*, gonophores; *st*, tabula gastrobasalis; *sm*, stomach of the central siphon; *sf*, its basal fissures (ostia of the radial canals); *sr*, proboscis; *ss*, mouth.

Fig. 2. A portion of the exumbrella; highly magnified. *ue*, The radial folds; *ce*, pallial canals; *pe*, radial rows of stigmata.

Fig. 3. Basal view of the centradenia, isolated by maceration. *un*, The white annular kidney; *sh*, the brown liver; *si*, central star composed of hepatic vessels; *sx*, basal insertions of the sexual siphons; *cr*, radial canals.

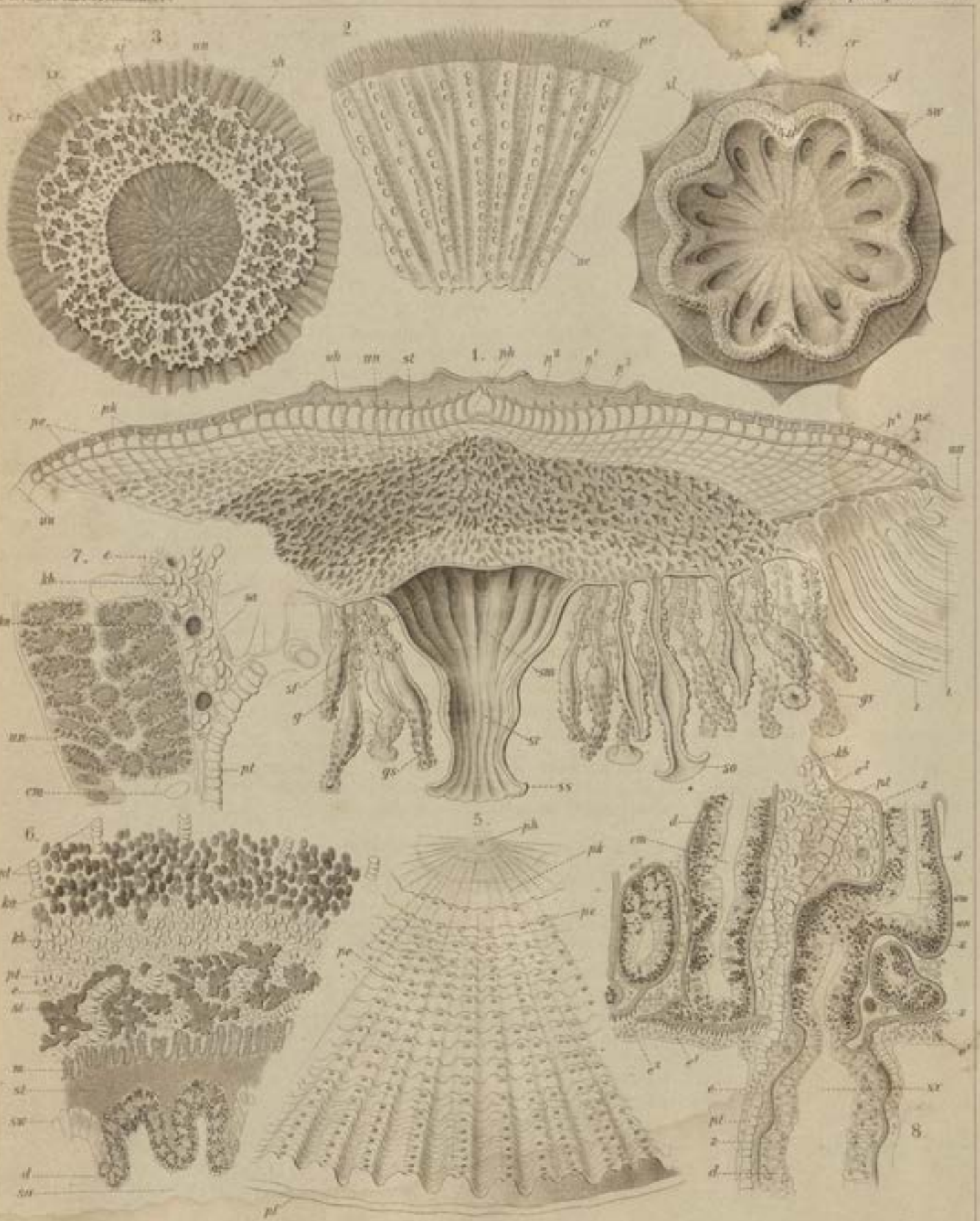
Fig. 4. Basal view of the central siphon, the walls of which are highly contracted and the octolobate mouth widely opened. In the fundus of the stomach are visible eight pairs of fissures (*sf*), the gastral openings of sixteen radial canals. *sw*, Radial folds; *sl*, thickened labial margin of the mouth.

Fig. 5. A radial segment of the pneumatocyst (*pf*) of another *Porpita* (*umbella*). The upper surface of the float exhibits numerous radial rows of stigmata (*pe*) in the back of prominent ridges. *pk*, Concentric ring-chambers; *ph*, central chamber.

Fig. 6. A small portion of the centradenia in horizontal section; highly magnified. *sa*, Central siphon; *sw*, radial folds of its inside; *d*, entoderm; *e*, exoderm; *m*, muscles; *st*, lamina gastrobasalis; *pt*, tracheæ; *kb*, enidoblasts; *ka*, auroblasts (air-secreting cells).

Fig. 7. A small portion of the kidney (*un*), in horizontal section; highly magnified. Characters as in fig. 6. *cm*, Hepatic vessels.

Fig. 8. A small portion of the kidney (*un*) and a sexual siphon (*sx*) in vertical section. Characters as in figs. 6, 7. e^1, Exoderm of the subumbrella; e^2, inner apophyses of it, piercing the fulcrum (*z*); e^3, air-secreting exoderm. Some tracheæ (*pt*) pierce the fulcrum and pass into the exoderm of the sexual siphon (*sx*).



PORPITA FUNGIA.

PLATE XLVI.

Order DISCONECTÆ.

Family PORPITIDÆ.

Porpitella pectanthis.

PLATE XLVI.

Porpitella pectanthis, n. sp. (p. 64).

Diam.

Figs. 1, 2. The complete corm, seen from above in the right half (1), from below in the left half (2). In the centre is visible the mouth of the sterile central siphon, surrounded by a corona of sixteen small gonostyles (or sexual siphons). The right half of the figure (1) shows the half of the radiate pneumatocyst, with eight marginal lobes. The margin of the umbrella is beset with a series of glands (dark points) and surrounded by a corona of numerous tentacles, composed of sixteen radial bunches, ... × 4

Fig. 3. Vertical meridional section through the lenticular biconvex umbrella and its appendages. *ph*, Central chamber of the pneumatocyst; *pq*, one of the eight radial chambers; *pk*, concentric ring-chambers; *um*, limbus umbrellæ; *t*, tentacles; *uc*, centradenia; *cm*, hepatic vessels; *st*, gastrobasal plate; *sa*, central siphon; *so*, its mouth, ... × 8

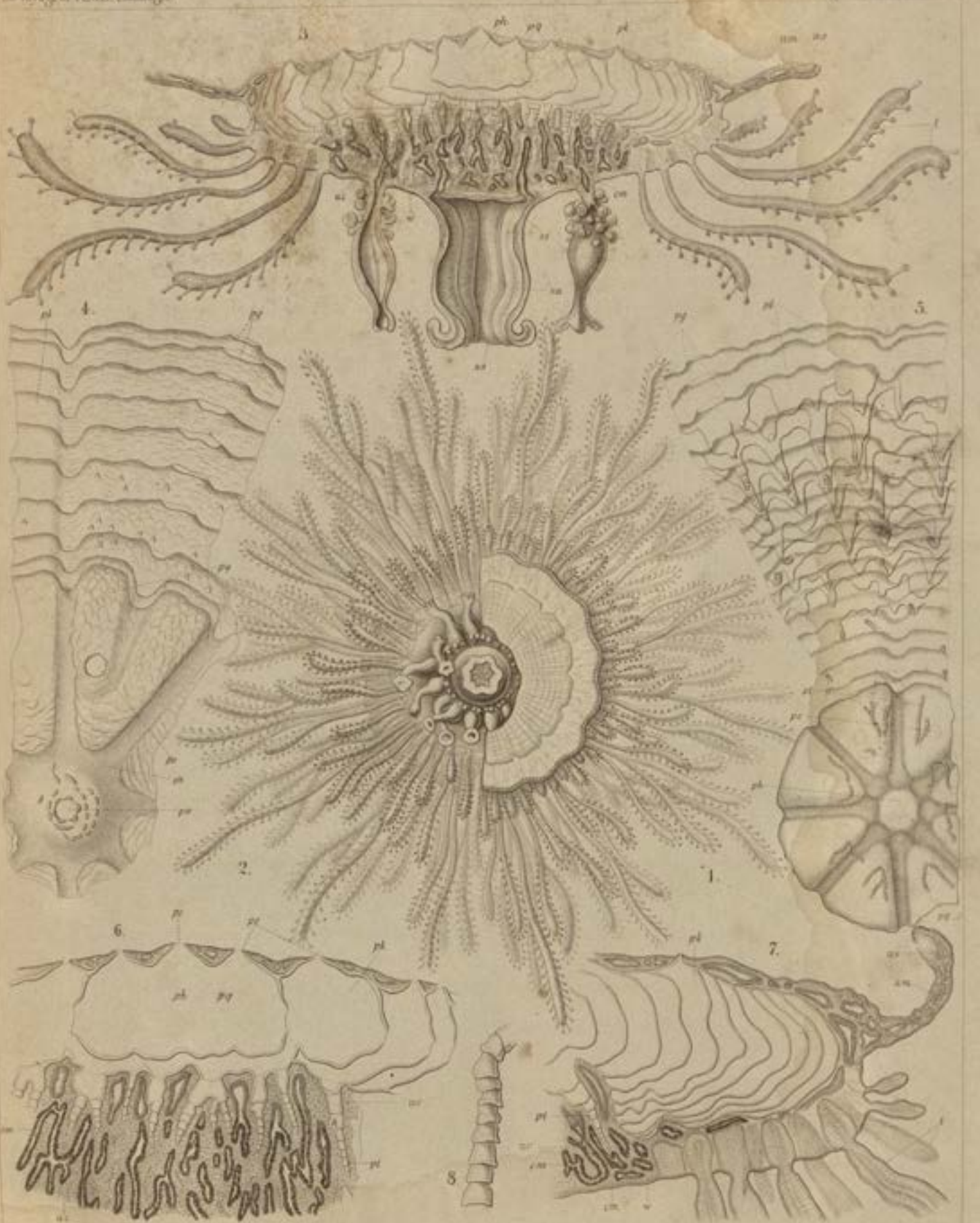
Fig. 4. Radial segment of the pneumatocyst, seen from above; highly magnified. *po*, Central stigma; *pe*, peripheral stigma; *ph*, central chamber; *pq*, radial chamber; *pk*, concentric ring-chambers; *pg*, pneumothyræ (pori communicantes), ... × 40

Fig. 5. Radial segment of the pneumatocyst, seen from below; highly magnified. *ph*, Central chamber; *pq*, eight radial chambers; *pe*, their stigmata (shining through); *pt*, tracheæ; *pk*, concentric ring-chambers, ... × 20

Fig. 6. Vertical section through the centre of the umbrella. Characters as in figs. 3, 4. *pt*, Tracheæ, ... × 20

Fig. 7. Vertical section through the peripheral part of the umbrella. Characters as in figs. 3, 4. *w*, Subumbrella; *pt*, tracheæ; *us*, muciparous glands of the umbrella-margin, ... × 20

Fig. 8. A portion of a single trachea, . . × 300



PORPITELLA PECTANTHIS

PLATE XLVII.

Order DISCONECTÆ.

Family PORPITIDÆ.

Porpema medusa.

PLATE XLVII.

Porpema medusa, n. sp. (p. 61).

Diam.

Fig. 1. The medusiform corm, seen from the exumbrellar or superior face. The central part of the exumbrella exhibits the radial rows of stigmata in the pneumatocyst, whereas in the peripheral part the forked branches of radial pallial canals are visible. The numerous tentacles of the surrounding submarginal corona are smallest in the uppermost row, . × 10

Fig. 2. Lateral view of the same corm in profile. (Compare figs. 3 and 4), . . . × 10

Fig. 3. Lateral view of the same corm, after removal of the tentacles. *uu*, Limbus umbrellæ; *t'*, the uppermost row of small tentacles; *tu*, polygonal facettes where the numerous tentacles have been attached to the subumbrella; *sx*, sexual siphons; *sh*, central siphon; *sr*, proboscis; *so*, its mouth, ... × 10

Fig. 4. Vertical meridional section through the same corm. *ph*, Central chamber of the pneumatocyst; *pk*, its concentric ring-chambers; *x*, gastrobasal plate; *uc*, centradenia; *w*, subumbrella; *t*, tentacles; *sx*, sexual siphons; *sh*, central siphon; *sr*, proboscis; *so*, mouth, . × 10

Fig. 5. Central portion of the subumbrella, seen from below. *sz*, Central siphon; *so*, its mouth; *sx*, sexual siphons; *g*, gonophores, ... × 20

Fig. 6. Horizontal transverse section through the middle portion of the corm. *uc*, Centradenia; *cm*, its hepatic vessels; *cr*, radial canals, running between eight chambered radial portions of the pneumatocyst; *cz*, coronal canal; *tu*, insertions of the tentacles, . . . × 20

Fig. 7. Central portion of the pneumatocyst, seen from above. *ph*, Central chamber; *pq*, eight radial chambers; *pk*, two concentric ring-chambers; *pr*, radial furrows; *pe*, eight peripheral stigmata, ... × 20

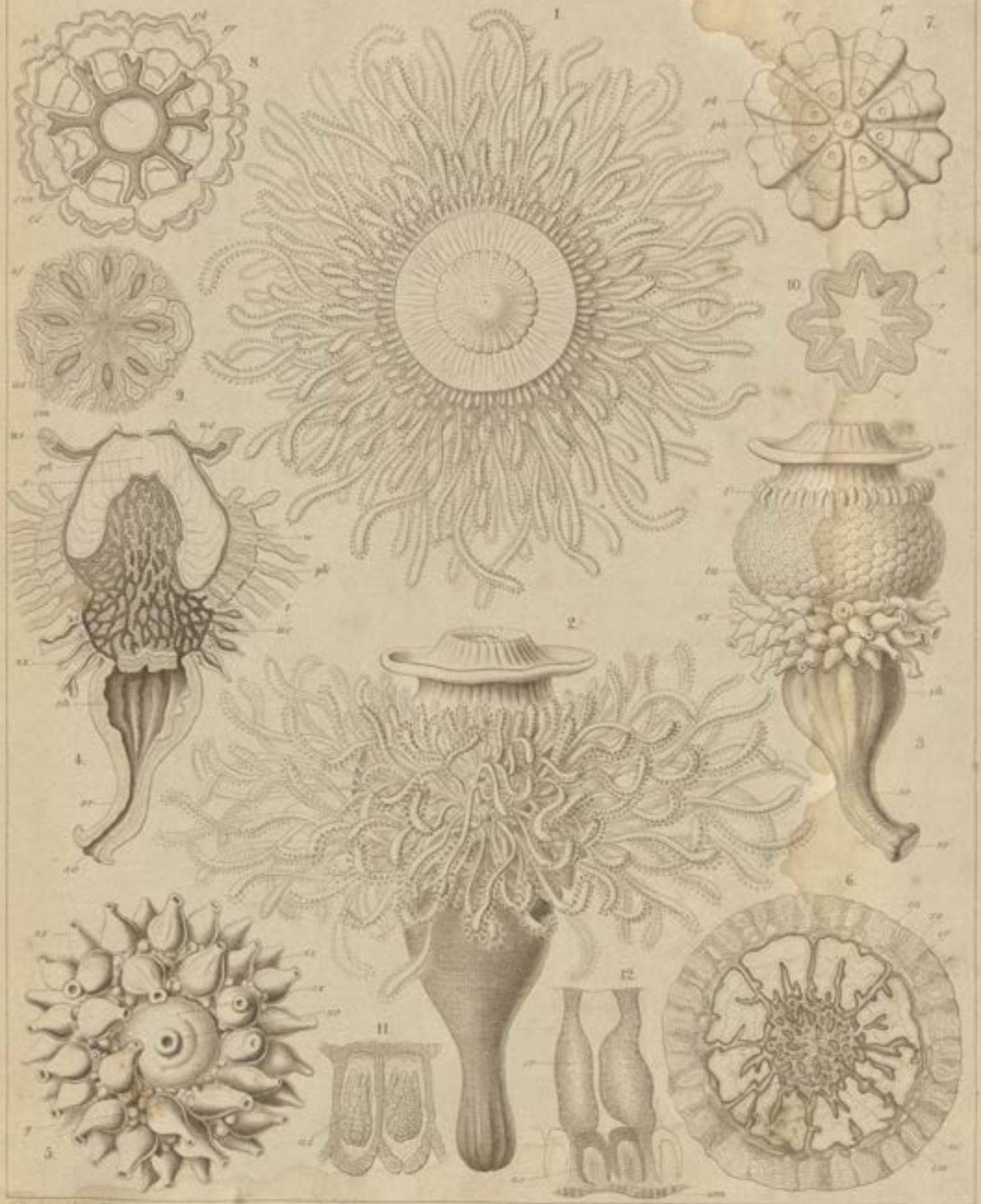
Fig. 8. Horizontal transverse section through the pneumatocyst and the uppermost portion of the centradenia (in the height of *x* in fig. 4). Characters as in figs. 6 and 7, . . × 20

Fig. 9. Horizontal transverse section through the lowermost portion of the centradenia (*uc*). *sf*, Ostia gastralia (openings of the eight radial canals into the central siphon), . . × 20

Fig. 10. Horizontal transverse section through the central siphon, with eight radial folds. *d*, Entoderm; *z*, fulcrum; *e*, exoderm; *sc*, gastral cavity, ... × 20

Fig. 11. Two muciparous glands of the umbrella-margin, ... × 400

Fig. 12. A small portion of the umbrella-margin. *cr*, Radial canals; *us*, muciparous glands, . × 200



PORPEMA MEDUSA.

PLATE XLVIII.

Order DISCONECTÆ.

Family PORPITIDÆ.

Porpalia pruhella.

PLATE XLVIII.

Porpalia prunella, n. sp. (p. 58).

Diam.

Fig. 1. The medusiform corm, seen from the superior or exumbrellar face. The radiate pneumatocyst shines through the central part of the exumbrella, which exhibits numerous radial ribs and rows of stigmata. The margin of the umbrella is beset with glands and surrounded by a corona of tentacles arranged in eight radial bunches, . . . × 10

Fig. 2. Lateral view of the same corm in profile. A deep subumbrellar circular furrow separates the margin of the umbrella (*um*) from the multiple corona of tentacles (*t*). Many tentacles are detached and their insertions only visible (*tu*); *w*, subumbrella; *ue*, exumbrella. The large central siphon (*sq*), with a long proboscis and octolobate mouth (*ss*), is surrounded by a corona of eight peripheral smaller siphons (*sx*) bearing numerous medusiform gonophores (*g*), . . × 20

Fig. 3. Vertical meridional section through the main axis of the same corm. The central air-chamber (*ph*) of the campanulate pneumatocyst is separated by the subspherical centradenia (*uc*) from the base of the central siphon (*sh*); *so*, central mouth; *st*, lamina gastrobasalis. Two smaller sexual siphons (*sx*) bearing gonophores (*g*) are visible beyond the corona of tentacles (*t*). The other characters as in fig. 2, . × 20

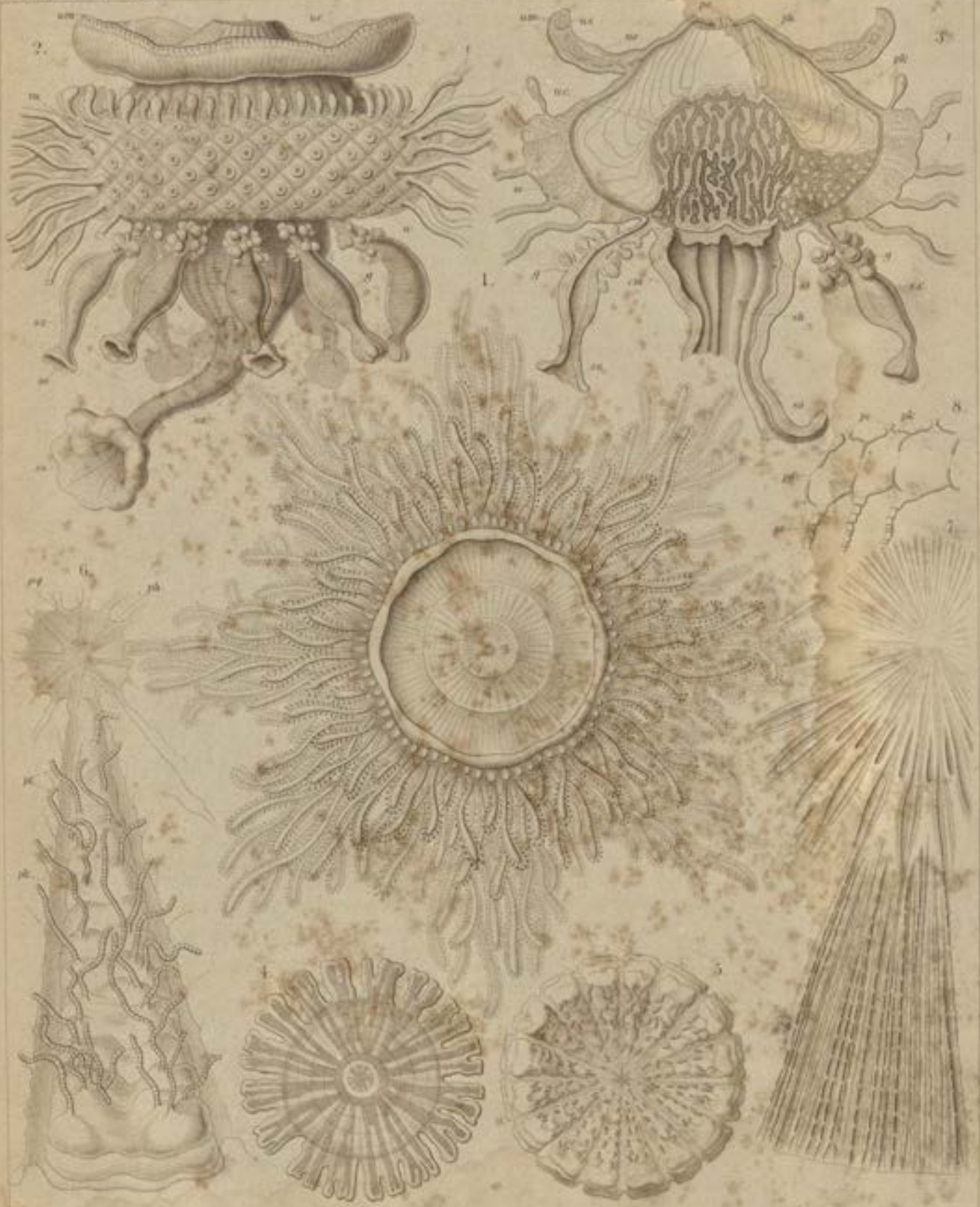
Fig. 4. Apical view of the pneumatocyst (from the superior side), with radial marginal lobes expanded, ... × 10

Fig. 5. Basal view of the pneumatocyst (from the inferior side), with numerous simple tracheæ, ... × 10

Fig. 6. A radial segment of the pneumatocyst (fig. 5), from the inferior side. *ph*, Central chamber; *pk*, concentric chambers; *pt*, simple tracheæ, × 50

Fig. 7. A radial segment of the centradenia, from the superior side, taken from *Porpita fungia* (Pl. XLV.). The numerous dentate radial lamellæ, which arise from the upper surface of the central gland, fit into corresponding radial furrows between the crests arising from the lower side of the pneumatocyst, ... × 20

Fig. 8. Radial section through the middle portion of the pneumatocyst, exhibiting three concentric air-chambers (*pk*). *pg*, Pneumothyræ (pori communicantes); *pe*, stigmata; *pt*, tracheæ, . . × 80



PORPALIA PRUNELLA

PLATE XLIX.

Order DISCONECTÆ.

Family DISCALIDÆ.

Figs. 1–6. *Discalia medusina.*
Figs. 7–12. *Disconalia gastroblasta.*

PLATE XLIX.

Figs. 1–6. *Discalia medusina*, n. sp. (p. 46).

Fig. 1. Basal view of the medusiform octoradial corm (from the inferior or subumbrellar face). The central siphon, with an octolobate mouth, is surrounded by a corona of eight palpons which bear numerous small medusiform gonophores on their basal pedicle. A corona of eight simple perradial tentacles, bearing a terminal cnidosphere, is placed between the palpons and the octolobate limbus umbrellæ, which is beset with a band of glands.

Fig. 2. Exumbrella (apical view of the corm). *po*, Central stigma; *pe*, corona of eight peripheral stigmata; *uu*, the eight marginal lobes; *t*, tentacles.

Fig. 3. Lateral view of the corm, in profile; the tentacles (*t*) are bent downwards. *po*, Central stigma; *pe*, peripheral stigmata; *uu*, margin of the flat octolobate umbrella; *gs*, gonopalpons; *g*, gonophores; *sa*, central siphon; *so*, its mouth.

Fig. 4. Meridional section through the same corm. *ph*, Central air-chamber of the pneumatocyst; *pq*, radial air-chamber; *t*, tentacles; *uc*, centradenia; *st*, gastrobasal plate. Other characters as above.

Fig. 5. Meridional section through the pneumatocyst alone. *ph*, Central chamber; *po*, its stigma; *pq*, two of the eight radial air-chambers; *pe*, their stigmata; *pt*, tracheæ.

Fig. 6. Vertical section through the limb of the umbrella (*uu*). *cr*, Radial canal; *cc*, circular canal; *us*, marginal muciparous gland.

Figs. 7–12. *Disconalia gastroblasta*, n. sp. (p. 48).

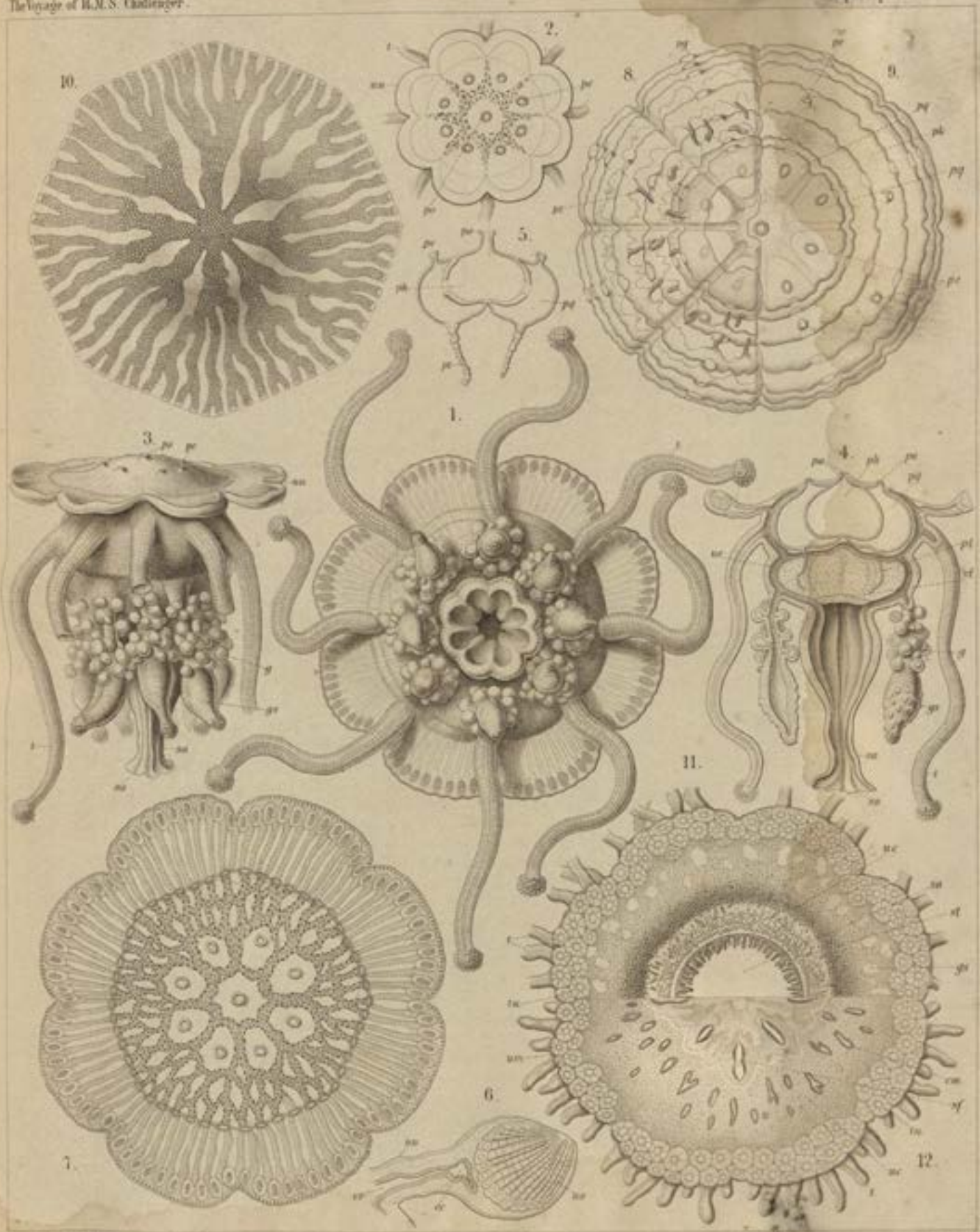
Fig. 7. Exumbrella (apical view of the umbrella, from above), with the octoradial system of the superficial exumbrellar canals. Eight perradial main vessels arise from the small ring which surrounds the apical stigma, and branch dichotomously. Their anastomosing branches unite in an octagonal coronal vessel, from which the simple peripheral radial canals of the limb arise. The octolobate margin is beset with a corona of glands.

Figs. 8, 9. Octoradial chamber-system of the air-filled pneumatocyst; fig. 9, superior or apical view (right half of the figure); fig. 8, inferior or basal view (left half). The central air-chamber is surrounded by a regular corona of eight interradial air-chambers (*pq*), and these by a peripheral octolobate corona which is composed of numerous concentric ring-chambers (*pk*). *pe*, Stigmata of the upper face; *pt*, tracheæ of the lower face; *pg*, interradial pneumothyræ (pori communicantes).

Fig. 10. Apical view of the octagonal centradenia (from above), with the brown "liver-star," or the system of eight radial, dichotomously branched hepatic vessels.

Fig. 11. Horizontal transverse section through the basal portion of the central siphon (*sa*), and the surrounding centradenia (*uc*). The octolobate margin of the umbrella exhibits the transverse sections of the basal portions of the tentacles (in a double row).

Fig. 12. Horizontal transverse section of the umbrella, somewhat above the plane of fig. 11. In the centre is visible the half of the gastrobasal plate (with four gastral ostia). *cm*, Hepatic canals.



1-6. DISCALIA MEDUSINA. 7-12. DISCONALIA GASTROBLASTA.

PLATE L.

Order DISCONECTÆ.

Family DISCALIDÆ.

Disconalia gastroblasta.

PLATE L.

Compare figs. 7–12 in Pl. XLIX.

Disconalia gastroblasta, n. sp. (p. 48).

Fig. 1. Basal view of the medusiform octoradial corm (seen from the subumbrella). The central sterile siphon exhibits an octolobate mouth-opening, and is surrounded by a corona of sixteen reddish-yellow palpons which bear numerous medusiform gonophores on their basal portion. An octoradial corona of numerous tentacles, arranged in eight equidistant bunches, is placed between the corona of palpons and the octolobate margin of the umbrella. Each tentacle bears three longitudinal rows of tentilla, or of pedunculate cnidospheres, two paired lateral and one inferior row.

Fig. 2. A fertile palpon, beset in the red distal half (*q*) with eight longitudinal rows of cnidonodes (*k*), in the yellow proximal half with clusters of medusiform gonophores (Discomitræ, *g*).

Fig. 3. The octolobate mouth of the large central siphon; its labial margin is armed with a series of cnidonodes.

Fig. 4. A group of tentacles (three larger and four smaller) and their insertion into the subumbrella.

Fig. 5. A single tentacle, with its three rows of tentilla (an odd inferior and two paired lateral rows).

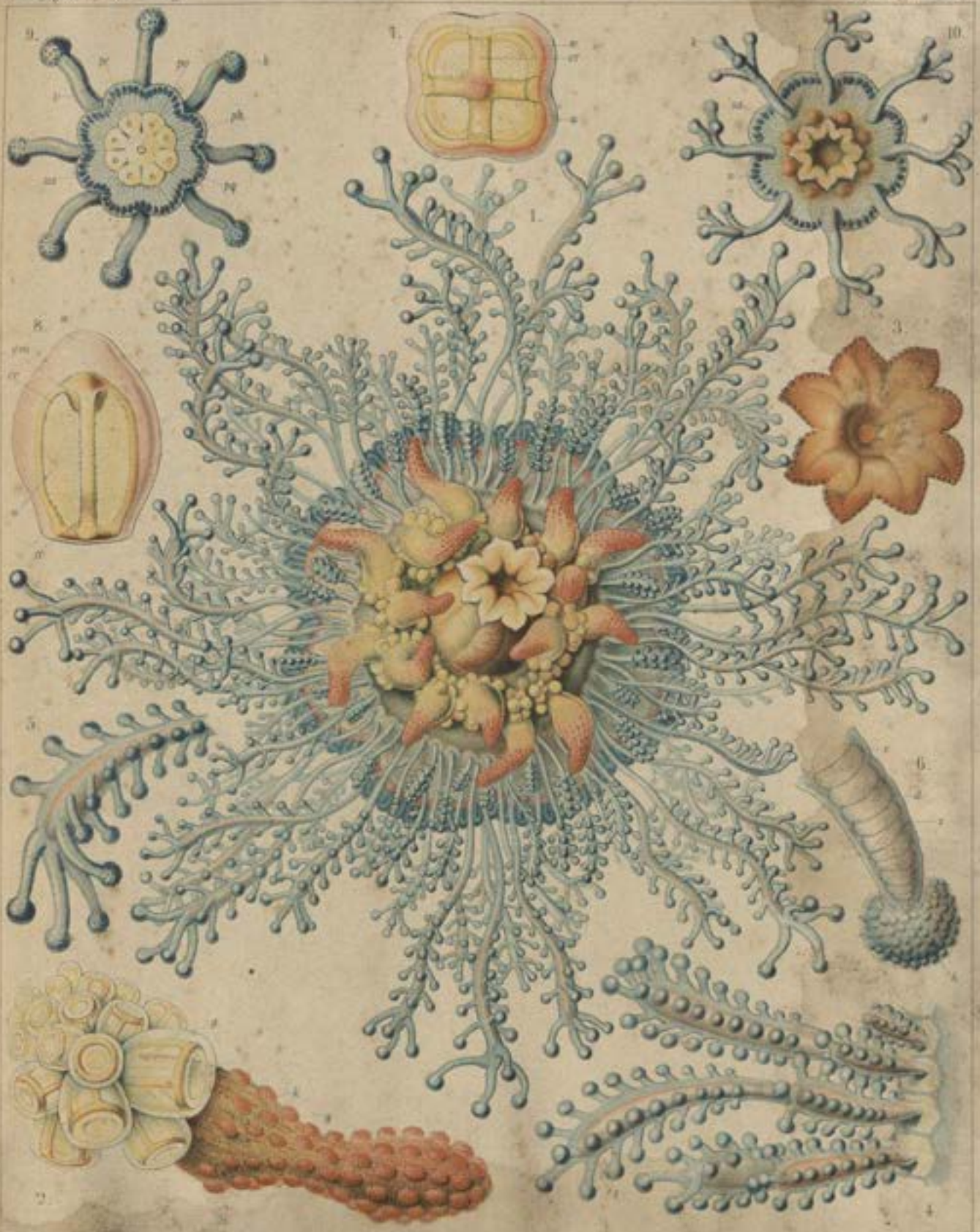
Fig. 6. A single tentillum. *d*, Axial column composed of large discoidal entoderm-cells; *e*, exodermal epithelium; *z*, fulcrum between them; *k*, terminal cnidosphere.

Fig. 7. Apical view of a Discomitra (or a medusiform gonophore). *u*, Exumbrella; *w*, subumbrella; *cr*, four crossed radial canals.

Fig. 8. Lateral view of the same Discomitra, in profile. *cr*, The four radial canals; *cc*, ring-canal of the umbrella margin.

Fig. 9. Apical view of a young *Disconula* (octoradial medusiform larva of *Disconalia*). The pneumatocyst (yellow) appears through the central portion of the (blue) exumbrella. *ph*, Central air-chamber; *po*, its stigma; *pq*, eight radial air-chambers; *pe*, their peripheral stigmata; *us*, muciparous glands of the umbrella-margin; *t*, tentacles; *k*, cnidospheres.

Fig. 10. Basal view of a somewhat older *Disconula*. The octolobate mouth of the central siphon and the corona of eight (red) incipient palpons are visible in the centre of the subumbrella. Each tentacle bears a terminal bunch of four tentilla (*k*). Characters as in fig. 9. (Compare on these larvæ, pp. 39, 45, 56, and *Discalia*, p. 46, Pl. XLIX. figs. 1–6.)



DISCONALIA CASTROBLASTA

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